THE UNITED STATES

STRATEGIC BOMBING SURVEY

COALS AND METALS IN JAPAN'S WAR ECONOMY

Basic Materials Division

April 1947

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This report was written primarily for the use of the U. S. Strategic Bombing Survey in the preparation of further reports of a more comprehensive nature. Any conclusions or opinions expressed in this report must be considered as limited to the specific material covered and as subject to further interpretation in the light of further studies conducted by the Survey.

FOREWORD

The United States Strategic Bombing Survey was established by the Secretary of War on 3 November 1944, pursuant to a directive from the late President Roosevelt. Its mission was to conduct an impartial and expert study of the effects of our aerial attack on Germany, to be used in connection with air attacks on Japan and to establish a basis for evaluating the importance and potentialities of air power as an instrument of military strategy, for planning the future development of the United States armed forces, and for determining future economic policies with respect to the national defense. A summary report and some 200 supporting reports containing the findings of the Survey in Germany have been published.

On 15 August 1945, President Truman requested that the Survey conduct a similar study of the effects of all types of air attack in the war against Japan, submitting reports in duplicate to the Secretary of War and to the Secretary of the Navy. The officers of the Survey during its Japanese phase were:

Franklin D'Olier, *Chairman.*
Paul H. Nitze, Henry C. Alexander, *Vice Chairmen.*
Harry L. Bowman,
J. Kenneth Galbraith,
Rensis Likert,
Frank A. McNamee, Jr.,
Fred Searls, Jr.,
Monroe E. Spaght,
Dr. Lewis R. Thompson,
Theodore P. Wright, *Directors.*
Walter Wilds, *Secretary.*

The Survey's complement provided for 300 civilians, 350 officers, and 500 enlisted men. The military segment of the organization was drawn from the Army to the extent of 60 percent, and from the Navy to the extent of 40 percent. Both the Army and the Navy gave the Survey all possible assistance in furnishing men, supplies, transport, and information. The Survey operated from headquarters established in Tokyo early in September 1945, with subheadquarters in Nagoya, Osaka, Hiroshima, and Nagasaki, and with mobile teams operating in other parts of Japan, the islands of the Pacific, and the Asiatic mainland.

It was possible to reconstruct much of wartime Japanese military planning and execution, engagement by engagement, and campaign by campaign, and to secure reasonably accurate statistics on Japan's economy and war-production, plant by plant, and industry by industry. In addition, studies were conducted on Japan's over-all strategic plans and the background of her entry into the war, the internal discussions and negotiations leading to her acceptance of unconditional surrender, the course of health and morale among the civilian population, the effectiveness of the Japanese civilian defense organization, and the effects of the atomic bombs. Separate reports will be issued covering each phase of the study.

The Survey interrogated more than 700 Japanese military, Government, and industrial officials. It also recovered and translated many documents which not only have been useful to the Survey, but also will furnish data valuable for other studies. Arrangements have been made to turn over the Survey's files to the Central Intelligence Group, through which they will be available for further examination and distribution.

Acknowledgment

The following report represents the combined work of three Sections of the Basic Materials Division, United States Strategic Bombing Survey (Pacific). The Section staffs responsible for the carrying out of the research in Japan and for the preparation of this report in Washington were: *Coal*—Lt. Cmdr. David A. Burr, USNR, 1st Lt. Raymond E. Burnes, AUS; *Coke, Iron and Steel*—Lt. Stefan H. Robock, USNR, Lt. (jg) Richard I. Galland, USNR, William Weinfeld, Howard F. Voigt; *Light and Non ferrous Metals*—Lt. Robert C. Beyer, USNR, Lt. William G. Jones, USNR, 1st Lt. Arthur M. Freedman, QM, Donald L. Colwell.

The research conducted in Japan depended in large measure upon the abilities and the unstinting efforts of the language personnel attached to the Division, namely, 1st Lt. Bayless A. Manning, SC, who assisted in the preparation of the Coal report as well, 1st Lt. Paul J. Bohannon, SC, and Robert P. Alexander.

The report could not have been completed, however, without the loyal and intensive work of the enlisted personnel, both men and women, who were attached to the Division in Japan and Washington.

W. Park Armstrong, Jr.
Major, AUS, Chief.

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SUMMARY

The output of Japan's basic industries, which had reached its peak early in 1944, had begun to decline some months before significant bomb tonnages were dropped on the Japanese home islands. This decline had been precipitated mainly by shortages of shipping space caused by blockade operations conducted by Allied submarine, air and surface operations.

An inescapable and fundamental limitation upon Japan's war potential was its serious deficiency in the natural resources without which modern war cannot be waged. Japan at home possessed in adequate amounts or quality practically none of the basic raw materials necessary for the use of even her limited industrial capacity to produce armaments. The few exceptions were impotent to offset the over-all defects in the mineral resources of the islands. Coal existed in quantity, but not of the right kind; iron was lacking in quantity; aluminous raw materials were notably lacking; there was some copper, but not enough; lead, tin, nickel, cobalt and chromium were grossly inadequate. Only zinc, in fact, was relatively sufficient.

Japan's planners had long recognized the glaring shortcomings of the homeland as a base for a major war against the West. Many of their political and military moves had been designed in large part to overcome the deficiency in raw materials and to bring areas containing them under direct control or domination. Regardless of what other considerations entered into the decisions to conquer Manchuria and large parts of China there can be little doubt that the important coal, iron, and other resources of those areas were major objectives. Peaceful infiltration into additional areas—the Philippines, Malaya, Netherland Indies—gained them access for a time to other supplies, but it left them at the mercy of hostile action by other powers. If Japan was to have the capability to prosecute a major war, there remained, of course, the necessity of developing its industries at home on the basis of the most economical use of foreign raw materials, of making secure the lines of communication to the northern mainland and of building as large stocks of metal as possible to be specifically held in reserve. Generally speaking, it is just that course which was attempted.

Beginning about 1937, Japan started to accumulate what she could of the seriously deficient metals, including steel (as scrap and ore), copper, lead, zinc, tin and most of the ferro-alloys. By late 1941 sizable quantities had been acquired abroad and shipped home for storage, amounting in some instances to more than a year's needs but coal and coke could not be stockpiled, and she had been unable to acquire much aluminum or bauxite. On the continent, in 1937 an ambitious program was begun to develop capacity to semi-process materials there before shipment to Japan. This program fell far short of its goals; for example, in Manchukuo pig iron capacity reached less than one-half and steel-making capacity less than one-third the planned levels. And because finishing processes remained concentrated in Japan the usefulness of expanding mainland production was dependent upon its flow to the homeland.

In Japan, an enormous effort over several years had been put into expanding some industries, integrating others, and making the islands as nearly self-supplying as it was possible to do. The program in most respects (excepting in the light metals) had been very nearly completed by December 1941 although it had been interfered within some important features by embargoes and by the steadily increasing resistance of the occidental powers to Japan's, by then, clear intentions. Entering upon the war, however, at a date of their own election, the top Japanese strategists, misjudging both the character and the duration of the fight ahead, felt they could look upon Japan's industrial resources with some equanimity. The fact that at that time Japan was able to produce at best no more than ten percent of the quantities of basic raw materials which the U. S. was producing was considered, but not very seriously.

The first early successes, which soon provided all but undisputed control over sources of most of the raw materials lacking at home, seemed to have furnished the economic security and wealth which would place Japan beyond the reach of her antagonists. All that remained to be done was for Japan to carry home the coal, iron and semi-processed materials from Manchukuo, the rich coking coal and iron from China, the equally good iron, manganese, chromite, and copper from the Philippines, the high-grade bauxite, tin, iron, and manganese from Malaya, nickel from Celebes, bauxite from the Netherland Indies, and copper, tin, tungsten, lead and zinc from Burma and Thailand. With the Navy guarding the sea lanes, and considering the distance from enemy bases, this seemed a possible task.

But almost before Japanese engineers and shipping firms could reach the spots they were to develop, the Allied blockade had gotten under way and soon began to take a toll of the merchant and transport vessels assigned to the task. By September 1942 little had been accomplished, and from then on the shipping situation (giving effect to the demands of military operations, the rising scale of ship sinkings and inefficient employment of available bottoms) was to act as an effective bar against the use of but a fraction of total cargo tonnage for the hauling of the resources which were available for the taking. Soon recognizing the bleak necessity for concentrating her efforts, Japan decided in early 1943 to forego all but a few of the raw materials available in the southern areas and instead to attempt full-scale mobilization of the nearer minerals, especially coking coal from North China, and iron ore from the Yangtze Valley and Hainan Island. For a while those efforts met with success; coal and iron ore imports, which had already turned downward, were stabilized for a few months.

A conspicuous exception among basic raw materials to the above was a strenuous campaign undertaken to get high-grade bauxite from the south for the critical aluminum industry; 1943 witnessed the high water mark for bauxite imports. The large windfall stocks of finished lead, tin and copper captured in the south—which required little shipping to move—were sent home when possible. But the iron of Malaya and the Philippines, which had accounted for 50 per cent of imports in 1940, had to be abandoned. Of copper, manganese, chromite and other ores that could not be processed where mined, little or no shipments could be afforded by the depleted shipping pool. Then, as U. S. submarines entered the Yellow Sea, even the vital bulk movements came under attack. To make matters worse, U. S. air forces began seriously to harass shipping on the Yangtze River and along the China coast.

Regardless of the amounts which were being brought in from the inner zone areas, the Japanese heavy industries were not able to maintain their operations without recourse to the stocks of raw materials built up before the war. By June 1944 cutbacks in production became necessary in nearly all fields; stocks were being stretched out, but they were dwindling fast. Some blast furnaces had to be shut down altogether, at government order, because iron ore receipts could not be parcelled out far enough. Drastic and difficult measures, often impractical, were resorted to; the aluminum industry tried desperately to shift over at the last moment to the use of North China shales in place of the bauxite for which its plants were almost wholly designed. Substitutions in steel alloys to less and less desirable formulas followed one another in rapid succession. Copper refineries operated at diminishing rates. Only the zinc industry maintained its position, depending as it had for some years chiefly on domestic resources.

The persistent and irreversible declining trend in the supply of products basic to the economy enforced a downward scaling of the production of end-products. It also tended to reduce pipe-line factors (stocks and work-in-process) to the minimum necessary to support existing levels of output. Pipe-line cushioning effects, as production of basic materials continued to decline, were therefore minimized. The effects of the shortages soon spiralled through the whole economy, as each industry, for want of products of the others, was able to produce less itself of what the others needed. Moreover, the enforced usage of increasingly poorer grade raw materials in an industrial economy characterized by its technological immaturity aggravated the difficulties resulting from the quantitative decline in output. These qualitative factors, stemming from the involuntary shift to unfamiliar processes, thereby accentuated the effectiveness of the blockade.

In June 1944 the very long-range air attack on the homeland and industries in Manchukuo began from deep in China. Operating under as adverse conditions as could be sustained, the small force available attacked the coking plants of the steel industry on the basis of the consideration that they were the most critical point in the industrial war machine within range. But the steel industry in Japan was even then already operating at less than half of its capacity; no plants were producing at capacity. In view of this fact, the problem of inflicting any very serious and lasting damage with the force which could be brought to bear presented extreme difficulties. Damage was done, to be sure. However, the loss in production which did result from these raids was made up in a few months, and thus no permanent cut in over-all output was effected by the China-based attacks.

By the time the Marianas-based long-range forces could be deployed, the decision had been made to shift to other target systems and types of attack. Thereafter, until near the close of the war, the heavy industries were not specifically attacked; they received secondary and incidental damage from attacks

against other targets, but not until the naval bombardments in July and August 1945, just before the surrender, were any of them singled out as primary objectives of an attack in force.

Nevertheless, by the end of the war the major heavy industries had been reduced to a state bordering on idleness. In July 1945 the coal supply was only 56 per cent of its wartime peak. Imports of indispensable coking coal were cut off. The supply of electrodes for the production of electric steel was almost exhausted after graphite from the mainland could no longer be brought in. Ingot steel output in June had already declined to a rate of 2,900,000 tons annually, comparing with a top year of 7,800,000 tons, and was certain to drop below 1,500,000 tons as the full effects of the shortages and damage were reflected in production. Aluminum output had practically ceased as bauxite stocks were exhausted months before and the emergency measures had failed; copper, lead and tin output had declined to 50, 30 and 10 per cent of their respective peak outputs during the war (and although some stocks of finished metal remained on hand, their use was limited by the availability of steel by that time).

The causes underlying the condition of the heavy industries went far back into the combined attack on Japanese raw materials and their supply lines. As the blockade noose had been drawn tighter and tighter around the main islands, access even to the nearby resources of Manchukuo, Korea and North China via the supposedly inviolable Japan Sea had been endangered and all but stopped. The secondary effects of the area raids aggravated somewhat further the position of those industries. The aerial mining campaign contributed mightily to the difficulties—especially as it affected the vulnerable inter-island movement of commodities which was an important characteristic of Japan's geography-dictated transport system. But even before that campaign got under way in April 1945 the major damage had been done, namely, the stock piles and surpluses of imported raw materials held in Japan proper neared exhaustion. Without them, industry had been forced to curtail its operations to the levels that could be supported by home-produced materials only, and in spite of enormous exertions the Japanese had been unable to make their domestic resources fill much of the gap.

The cumulative effects of the attack on shipping, and mining of ports, were predominantly responsible for the condition of the Japanese heavy industries at the end. In those industries improvization is of little avail; bulk raw materials must move in unceasing volume; 24-hour-a-day operation is a necessity; and when the whole series of manufacturing and fabricating industries which depend on the heavy industries for their raw materials could no longer be supplied with more than a third or so of their requirements, the war potential of Japan approached a similar figure. This remaining fraction of Japan's war potential was vulnerable to an attack on her railroad network. Once transportation by sea had been substantially eliminated, the heavy industries were wholly dependent on Japan's few rail lines for the movement of even her inadequate domestic materials.

PART I

COAL IN JAPAN'S WAR ECONOMY

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I

INTRODUCTION

Japan's coal mining industry was not itself a target of strategic bombing. While coal traffic was the major item in sea and land transportation, attacks on that complex were not specifically directed at interdiction of coal movement. The scope of this report is therefore primarily an analysis of wartime developments in coal supply, and its importance to Japan's war economy. Accordingly, the main emphasis will be placed upon (1) the extent to which Japan failed to recognize the importance of coal and to adopt realistic measures to obtain maximum supply from available resources, (2) the course of Japan's failure to expand or even maintain domestic production during the war years although the mines generally were not attacked, and (3) the impact of the production and transportation crises on the essential supply of coal to consuming industries. However, a certain amount of corollary information on the mining and transportation of coal which should be of interest to specialists in that field was collected in Japan; this has been incorporated in a series of annexes which will not be distributed generally, but will be available upon request.

The major facts of Japan's basic coal position were well known to Allied intelligence. Official statistics on coal resources and mining development in Japanese-occupied territory were generally available in published form for the period prior to 1937. During the following years only occasional references of dubious authenticity were released publicly by the Japanese, and appraisal of developments in the coal supply and their effects on the enemy's industrial potential was largely restricted to deductions based on previous knowledge and fragmentary information derived from various intelligence channels. It is noteworthy that the major conclusions of Allied intelligence on this subject have been confirmed as substantially correct by full details obtained during the Survey's investigation; no new facts have been uncovered which, had they been known, would have been likely to have changed the recommendations, presented by intelligence to the staffs charged with strategic policy-making, that coal supply be given a high priority as a critical target.

This report is based on records and information from the files of Japanese government bureaus, the Coal Control association (SEKITAN TOSEI KAI), The Japan Coal company (NIHON SEKITAN KAISHA, since 1940 the sole distribution agency) and leading mining companies; on interviews with key personnel of the above organizations; and on examination of the Miike colliery in Kyushu and the Osaka distribution center. Collection of information was considerably complicated by the loss of records in raids and the great difficulty of communications with Japanese regional offices, and by the fact that in some instances the desired statistical series had never been kept. Insofar as possible, inconsistencies in statistics obtained from various sources have been reconciled and eliminated.

II

VULNERABILITY OF JAPAN'S BASIC COAL POSITION

. *Importance of coal in Japan's war economy*

Seriously deficient in natural gas and petroleum, Japan was almost entirely dependent on waterpower and coal for industrial energy. It is estimated that about two-thirds of the total energy consumed by the Japanese war economy in 1943 was derived from coal[1], in spite of an increase of more than 600 per cent since 1920 in hydroelectric generation capacity in Japan proper. Moreover, seasonal fluctuation in rainfall and the absence of large reservoirs made necessary the existence of sizeable standby thermal generation equipment. By comparison, in 1943 coal contributed approximately one-half of all available energy in the United States, and nine-tenths of that used in Germany.

Coal was indispensable in the operation of Japan's blast furnaces and irreplaceable as a raw material for much of the chemical industry. It was the pri-

[1] Total coal consumption in Japan proper that year was 59,740,000 metric tons; the coal equivalent of hydroelectric power generated was 25,350,000 metric tons, taken at the prevailing rate of 1.87 lbs. of coal per KWH. Discarding other minor sources of energy, coal thus represented approximately 70 per cent of the total.

mary fuel for the railway network. Disruption of the supply of coal would inevitably have resulted in widespread paralysis of the nation's war production.

2. *Lack of self-sufficiency*

Considering the extent of her dependence upon coal and her limited resources, Japan was poorly equipped to engage in a life and death struggle with a major industrial power. Coal reserves were small in comparison with those of the world's great coal producing nations. At no time did production in Japan proper attain the minimum goal of 60,000,000 tons[1] set by the government early in the war, only about ten per cent of the output of the United States. Nearly all coal produced in Japan proper is medium-to-low grade bituminous; practically none is suitable for making good metallurgical coke unless blended with imported coals.

Japan was vitally dependent on coal imports to supplement her domestic supply. Of especial importance was coking coal from Karafuto and North China-Inner Mongolia, without which the Japanese iron and steel industry could not hope to function efficiently.

3. *Dependence on inter-island transportation*

The coal fields in Japan proper are poorly situated with respect to major centers of consumption, with the exceptions of the industrial area of northern Kyushu and the much smaller steel industry of southern Hokkaido. The location of the industrial concentrations of central Honshu formed one of the weakest links in the production-consumption chain. Honshu's wartime coal output, never more than 15 per cent of the total production of Japan proper, furnished only about one-fourth of the coal used on that island. The bulk of its coal supplies had to be carried 250–600 miles from mines in Hokkaido and Kyushu and the other Inner Zone areas along shipping lanes which were partially accessible to submarine attack from the beginning of the war, and were within range of Allied air attacks in the final months. In 1941, for example, 13,823,000 tons of the 31,862,000 tons mined in Kyushu were sent to Honshu, as were 7,329,000 of the 15,747,000 tons produced in Hokkaido. Prior to the war, all shipments were by water, and extensive handling facilities existed at ports of origin and receipt.

[1] Metric tons and fiscal years (April–March) are used throughout this report, except when otherwise noted.

III

JAPAN'S PREWAR COAL POSITION

1. *Domestic reserves and production*

a. *Reserves.* Considering the indispensability of coal to the Japanese economy and the limited quantity and inferior quality of her coal resources, Japan's industrial pyramid even at the outset of the war rested on a surprisingly narrow base. According to data submitted by the Fuel Bureau, Ministry of Commerce and Industry, known remaining coal deposits in Japan proper, as of 1 April 1945, were estimated at approximately 9,200,000,000 tons, or about 5.8 times the amount mined prior to that date. The combined coal reserves as of 1928 in the United States and the United Kingdom, on the other hand, totalled 3,402,000,000,000 tons. Of the known deposits in Japan proper, bituminous coal accounted for 88 per cent, and semi-anthracite and lignite for the remaining 12 per cent. All but a trifle of the reserves were located in four areas: (1) northwestern Kyushu with large fields of medium grade bituminous, (2) Hokkaido with extensive deposits of higher quality gas-producing bituminous, (3) Yamaguchi prefecture in western Honshu with limited reserves of lower grade bituminous, lignite and semi anthracite, and (4) the Joban fields of eastern Honshu with some sub-bituminous and lignite (Appendix Table 1). In general, the bituminous coals mined in Japan are unsuitable for the manufacture of metallurgical coke although some of the coals of Hokkaido and Kyushu produce a satisfactory coke of metallurgical quality when blended with imported coking coals.

Coal seams in the Hokkaido fields are for the most part thick enough for efficient modern working, but most of the deposits in Honshu and Kyushu are in thin seams, and nearly all of the seams are sharply

inclined. Many of the mines are deep and wet, necessitating extensive and continual pumping. The Hokkaido mines are newer and better engineered, but have great gas hazards. Temperatures in many of the mines of Kyushu and Honshu are very high, causing considerable fluctuation in winter and summer production. Extreme low winter temperatures in Hokkaido have also imposed serious seasonal handicaps on mining in that region.

b. *Development of the coal mining industry.* (1) *Structure of the industry.* The large mines were, with few exceptions, operated by a handful of large mining companies owned or controlled by the Zaibatzu; chief among them were Mitsui Mining Co., Mitsubishi Mining Co., Hokkaido Colliery and Steamship Co. (Mitsui controlled), and Sumitomo Mining Co. Those four alone accounted for 48.5 per cent of total production in 1944 (Appendix Table 5).

A feature of Japanese coal mining was the great number of very small mines producing from a few tons to as much as 50,000 tons per year. These were usually independently operated by small enterprisers under temporary loan financing by banks or distributors. Their operations were immediately dependent upon favorable market or subsidy conditions. In this number are also undoubtedly some mines which were actually not in full operation, as prospecting pits were not invariably excluded.

It is noteworthy that of 640 mines opened or reopened during the decade 1931–40, only two had an "expected annual production" of more than 300,000 tons and only 22 were expected to yield between 50,000 and 300,000 tons per year (Appendix Table 5). In 1932, there were 361 mines in operation in Japan proper. Of these only 24, or 6.6 per cent, had an annual output in excess of 300,000 tons, and they produced 53.0 per cent of the nation's total. By 1940, the total number of mines had nearly doubled, with the 45 largest mines accounting for 64.5 per cent of the entire output for the year.

(2) *Technical developments.* Coal mining methods in Japan were extremely primitive until the early 1900s. By 1910, a few of the most modern mines were using some electricity for pumping and hauling, and were operating on the longwall principle. World War I, which boomed production to a level not again attained until 1934, spurred the adoption of some features of Western technology, and also compelled the Japanese to start the manufacture of many items of mine supply which formerly they had imported. Although the end of that war temporarily curtailed the demand for Japanese coal, the industry continued to make steady progress in the following decade.

TABLE I.—*Comparison of number and proportion of total production of various sized mines in Japan proper in fiscal years 1932 and 1940.*

[Production in thousands of metric tons]

Size of annual production	Number of mines	Percentage of total number	Production	Percentage of total production
1932				
More than 300,000 tons	24	6.6	14,876	53.0
150,000 to 300,000 tons	31	8.6	6,629	23.6
50,000 to 150,000 tons	50	13.6	4,710	16.8
Less than 50,000 tons	256	70.9	1,838	6.6
Total	361	100.0	28,053	100.0
1940				
More than 300,000 tons	45	6.5	36,959	64.5
150,000 to 300,000 tons	37	5.3	7,837	13.7
50,000 to 150,000 tons	73	10.5	7,127	12.4
Less than 50,000 tons	541	77.7	5,386	9.4
Total	696	100.0	57,309	100.0

Source: Appendix Table 2.

The greatest advance in adoption of more efficient techniques and equipment was made during the late 1920s and early 1930s. By 1933, of the 72 most important mines in Japan, 69 had replaced the pillar-and-room system with the longwall method, to which the incline in the majority of Japanese mines was well suited. Early in the 1930s, Japan began to supply in part her own needs for heavy mining machinery, such as horizontal cutters, drills, and conveyor equipment, and its use spread rapidly among the larger mines. Technological advances made during this period bore fruit during the balance of the 1930s, as demand for coal rose in response to Japan's industrial expansion. Production in Japan proper soared 67 per cent from 34,258,000 tons in 1929 to 57,309,000 tons in 1940.

Japan's peak in mining efficiency, as gauged by average annual output per employe, occurred in the depression year 1933 when it reached 227 tons, compared with 107 tons in 1922 and 153 tons in 1930. (The comparable average in the United States in 1933 was 723 tons.) This marked increase in efficiency stemmed in part from the depression conditions and curtailment of production; some marginal operations were halted and only the more rewarding seams were worked. There was an ample supply of skilled labor available; mining equipment was relatively plentiful. These factors produced a condition diametrically opposite to that resulting from the demand for expanded output which began in 1934 and which became especially acute after 1937.

Following 1933, the efficiency index declined steadily throughout the remainder of the decade, and

in 1940 was only 173 tons. This trend, in the face of major advances in technology in the large mines, reflects the meagerness of Japan's resources and reservoir of skilled mining labor, as well as the drive for increased production at any cost. Each year more and more low grade, ill-equipped and poorly engineered mines were brought into production. And each year the galleries of the high-grade mines were pushed deeper and deeper. The pressure for immediate production demanded sacrifice of sound long-range development of such resources as were available. Absence of this developmental groundwork was to prove one of the obstacles to achieving greater production during the war years.

(3) *Japan's supply of coal mining labor.* Coal mining has long been an unpopular occupation in Japan. The mines are extremely hazardous because of the usual presence of explosive gas and lack of safety maintenance which would be considered essential by Occidental standards. Volcanic hot springs raise temperatures in many mines of Kyushu and Honshu well above 90 degrees; in Hokkaido mines, sub-arctic winter temperatures produce the opposite extreme of discomfort. Wages in the prewar period were notoriously low.

As a consequence, turn-over of miners has normally been very high. While some 20 per cent of the underground workers could properly be termed permanent, the turn-over rate of the remainder was as a rule well over 100 per cent. Prior to 1940, most of this casual segment of the labor force was composed of farmers who worked in the mines only long enough to accumulate a few yen before returning to the fields. Training to achieve proficiency in the use of mechanized equipment was variously considered to take from six months to two years. The resultant inadequate level of general skill is obvious.

After the beginning of the war in China in 1937, the situation became progressively more critical as experienced miners were called into military service. In 1939 the shortage of husky Japanese for work in the mines had become so acute that "enforced collective immigration" of Korean contract laborers was begun.

(4) *Supply of mining materials and equipment.* One of the most critical factors in Japan's coal production crisis late in the war was the shortage of steel products, cement, and rubber. The industry was a large user of rolled steel shapes for props and mine transportation facilities, and of steel cable. Cement was an essential of efficient operation, and rubber was necessary particularly for the many belt conveyors. Explosives were indispensable, but available in required quantity. Mine timbers and supplies of lumber were fairly plentiful in the coal field areas and never became a critically short item.

All of the better mines were highly electrified, and demand for heavy electrical equipment was great. During the 1930s, the more important mines converted to use of specialized heavy equipment such as cutters, picks, and drills, and the mines became more dependent on washing and sorting installations. Most of this specialized equipment was manufactured by a handful of suppliers such as Hitachi, Mitsubishi Denki, and Yasukawa Denki. Several of the larger mines had machinery plants at the colliery, as for example those at Miike, capable of major repairs and some fabrication. Repairs to machinery for most mines, however, were done in large part by scattered foundries and machine shops throughout the coal regions.

(5) *The government's relation to coal mining before 1940.* Exploitation of Japan's underground mineral resources was subject to license and concession of the Imperial Government. Prospecting rights and mining rights were issued by the Fuel Bureau of the Ministry of Commerce and Industry, which required submission of periodic reports of operations and production.

Prior to 1940, however, direct governmental control of actual production and distribution was largely limited to various licensing and supervisory measures incident to enabling operators to exploit the coal reserves. Most important regulation was effected through a government-sanctioned cartel formed by the large mining interests, known as the Federation of Coal Mine Owners, which had been established in 1921, the chief policies of which were directed to price stabilization and control of production. In 1932 the Federation organized a subsidiary, the Showa Coal Co., which assumed a practically complete monopoly of sale and distribution of domestically produced and imported coal. When a coal shortage appeared in 1937, the government stepped in to fix prices and regulate distribution, acting through the Showa Coal Company.

The increasing inability of domestic coal production to keep pace with Japan's industrial expansion became really critical for the first time in 1939, when abnormally low rainfall called for unusually high coal consumption in thermal electric power plants. To enforce a stringent policy of control of prices to consumers and to encourage maximum production the government passed in 1939 the Coal Distribution

Law. Under its terms the Showa Coal Co. was transformed in April 1940 into the Japan Coal Co., capitalized half by the government and half by the mining interests. This quasi-governmental agency was given a total monopoly over sale and distribution of coal. Production and imports were purchased by the company at prices based on cost-plus-bonus to spur output; sales prices were frozen as of 1 April 1940.

By 1940 the government's policy of pressing for immediate output had begun to be reflected in the abuse of mines and decline in efficiency which was later to result in a collapse of the nation's coal production capacity. Construction and repair were already being neglected in many of the mines as materials and skilled manpower were turned to military and end-products uses. Consumption of steel for mining fell 18 per cent from 1936 to 1940, while coal production increased 37 per cent. The number of miners employed rose from 251,000 (all Japanese) in 1938 to 338,000 (including 45,000 Koreans) in 1940. Despite the slighting of development and maintenance work—and with a larger proportion of the labor force engaged in actual digging—the average annual output per miner fell from 193 tons in 1938 to 173 tons in 1940.

c. *Rapid growth of production, 1931–40.* The depression years of the early 1930s saw a definite slump in the production of coal in Japan proper. Total output dropped from 34,258,000 tons in 1929 to a low of 27,987,000 tons in 1931. Thereafter the pendulum swung back, and by 1936 domestic production had risen by 50 per cent to 41,803,000 tons. The outbreak of the China Incident in 1937 ushered in a period of rapid expansion for the coal mining industry. Domestic production was stepped up sharply and by 1940 had reached an all-time high of 57,309,000 tons, a level more than twice that of 1931. The greatest gain took place in Hokkaido where production jumped from 6,134,000 tons in 1931 to 15,378,000 tons in 1940, when it contributed 26.8 per cent of the total output.

. *Imports*

a. *Vital dependence on imports.* As previously noted, coal imports were essential to the war economy of Japan proper; the iron and steel industry was especially dependent for coke on the higher grade blending coals mined in Karafuto and North China. Substantial quantities of other types of coal were also needed to meet expanding industrial requirements.

TABLE 2. *Coal production in Japan proper, by islands, fiscal years 1931–40*

[In thousands of metric tons]

Year	Hokkaido		Honshu		Kyushu		Total
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	
1931	6,134	21.9	4,179	14.9	17,674	63.2	27,987
1934	7,627	21.2	5,310	14.8	22,988	64.0	35,925
1936	9,288	22.2	5,865	14.0	26,650	63.8	41,803
1937	10,730	23.7	6,054	13.4	28,474	62.9	45,258
1938	12,335	25.3	6,604	13.6	29,745	61.1	48,684
1939	13,583	25.9	7,815	14.9	31,011	59.2	52,409
1940	15,378	26.8	8,876	15.5	33,055	57.7	57,309

Source: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai), November 1945. Appendix Table 8.

The existence of vast reserves of good, easily mined coal in the occupied areas of the continent thus naturally figured prominently in the long range plans of the Japanese. While goals for domestic production were always too high to be reached under existing conditions, and diversion of technicians and material to the continental mines did not decisively aggravate the shortage which plagued the Japanese mines, there is little doubt but that the optimistic war planners counted on imports from Japanese-controlled mines in Karafuto, Manchukuo and China to provide an increasing share of the supply needed for the realization of their expansion plans. There is also little doubt that this attitude contributed to their failure to develop and execute a thorough, realistic program for maximum long-range exploitation of resources in the home islands.

b. *Development of coal production in Karafuto, Korea, Manchukuo and North China.* Coal resources in Karafuto, Korea, Manchukuo and North China were enormous, and the prewar production of each region was capable of substantial expansion. Had they been given freedom from hostile interference and sabotage, labor, the necessary equipment and materials, and sufficient transportation from mine to port and thence to consumers in Japan proper, the Japanese would have had an almost unlimited supply of coal for the taking. It is small wonder that they succumbed to that lure as an attractive alternative to the harsh and unpopular measures which would have been required to squeeze the maximum of production from their domestic resources, particularly in view of their inescapable dependence on imported coking coal.

In 1938, the year following the Japanese seizure of North China, the total coal output in Karafuto, Korea, Manchukuo and North China-Inner Mongolia came to 31,801,000 tons. The strenuous efforts exerted

by the Japanese to increase production in those areas met with considerable success during the years immediately following, and by 1940 the amount produced had risen by more than 60 per cent above the 1938 level to 51,659,000 tons, as shown in the following table:

TABLE 3.—*Production of coal in Karafuto, Korea, Manchukuo and North China-Inner Mongolia, fiscal years 1938 and 1940.*

[In thousands of metric tons]

Area	1938	1940	Percentage of increase
Karafuto	3,435	6,465	88.2
Korea	3,419	6,096	78.3
Manchukuo	15,988	21,132	32.2
North China—Inner Mongolia	9,959	17,966	80.4
Total	31,801	51,659	62.4

Source: Compiled from data submitted by the Japan-Manchukuo Trading Co. (Nichiman Shoji Kabushiki Kaisha), the Japan, Manchukuo, China Coal federation (Nichi Manshi Sekitan Renmei), and the Greater East Asia Ministry (Dai Toa Sho), November 1945. Appendix Table 7.

c. *Prewar imports.* Even during the depression year 1931, coal shipments from all areas to Japan proper totalled 3,110,000 tons. The next seven years witnessed a steady rise in the volume of imports, and by 1938 it had reached a level of 6,493,000 tons. During the two following years the upward trend accelerated sharply, jumping by about 56 per cent to a peak figure of 10,123,000 tons in 1940. Of that total, Karafuto and North China-Inner Mongolia contributed about 70 per cent.

TABLE 4.—*Imports of coal to Japan proper, fiscal year 1940*

[In thousands of metric tons]

Source	Amount	Percentage of total imports
Karafuto	3,328	32.9
Korea	1,467	14.5
Manchukuo	773	7.6
Formosa	263	2.6
North China-Inner Mongolia	3,800	37.5
French Indo-China, etc.	492	4.9
Total	10,123	100.0

Source: Compiled from data submitted by the Japan Coal Co. (Nihon Sekitan Kaisha), November 1945. Appendix Table 23.

3. *Exports*

Although Japan proper from 1931–40 was a net importer of coal, some bituminous coal was shipped from Kyushu during that period. Such exports, which went mainly to Korea, South China, and the Philippine Islands, averaged less than 2,000,000 tons and thus exerted only a negligible influence on the over-all supply position.

4. *Consumption pattern*

From 1933 to 1940 coal consumption in Japa proper, excluding the quantity used at the coal mine more than doubled, rising steadily each year fro 31,466,000 tons in 1933 to the peak year of 1940 whe the total used amounted to 63,622,000 tons. Sul stantial increases in consumption during the perio took place in the iron and steel, metal mining ar refining, gas and coke, electric power, chemica ceramics and railway industries, as noted belo

TABLE 5.—*Comparison of selected major consumers of coal Japan proper, fiscal years 1933 and 1940*

[In thousands of metric tons]

Industry	Coosumed in 1933	Consumed in 1940	Percentag increase
Iron and steel	4,064	11,439	18
Chemical	2,673	7,150	16
Electric power	1,881	5,598	21
Railroads	3,408	5,568	6
Ceramics, including cement	2,871	4,665	6
Gas and coke	1,881	3,945	10
Metal mining and refining	197	857	33

Source: Compiled from data submitted by the Japan Coal Co. (Nihon Sekitan Kaish November 1945. Appendix Table 33.

By 1940 the wartime pattern of coal consumptio was crystallizing. Whereas in 1933 the iron and ste industry had used 12.9 per cent of the total co consumed, in 1940 the proportion consumed by th industry had risen to 18.0 per cent. Ship bunkeri had dropped from 12.8 per cent in 1933 to 5.8 in 194 The chemical and electric power industries, whi had ranked seventh and ninth respectively in t list of consumers in 1933, had risen to the second a fourth positions in 1940. The percentage of tot consumption by major users in the two years wa

TABLE 6.—*Major coal consumers in Japan proper in terms the percentage of total coal consumer, fiscal years 1933 a 1940.*

Industry	Percentage of total coal consume	
	1933	1940
Iron and steel	12.9	1
Chemical	8.5	1
Fiber and textiles	10.4	1
Electric power	6.0	
Railroads	10.8	
Ceramics, including cement	9.1	
Gas and coke	6.0	
Ship bunkering	12.8	
Total	76.5	7

Source: Compiled from data submitted by the Japan Coal Co. (Nihon Sekit Kaisha), November 1945. Appendix Table 34.

JAPAN'S COAL POSITION 1941–45

1. *Government policy and controls*

a. *Attitude of the war planners.* The course of official Japanese policy toward coal production problems during the years after 1937 was determined by the optimistic gambling attitude of the war planners. They expected that ample supplies of coal would be forthcoming from Karafuto, Manchukuo and North China, and tended to ignore the realities of the mining situation in Japan proper. That resulted in a convenient avoidance of the drastic measures which alone could have secured the maximum sustained exploitation of domestic coal resources. Not until late in 1944 was the full portent of Japan's weakness in this basic material realized, and by then the situation had deteriorated beyond remedy.

A 70,000,000-ton goal for annual coal production from the mines of Japan proper had been set as early as 1938, despite the industry's protests that 60,000,000 tons was the maximum possibly obtainable under the most favorable conditions which could be expected, and even that contingent upon complete cooperation in filling the mine operators' demands for labor and materials. It was explained that such a rate of production could only be achieved at the expense of normal maintenance and development, and by concentration on short-range exploitation of the richest seams, resulting in an inevitable collapse of production capacity until the mines could be restored.

Leaders in the mining industry voiced a persistent complaint that officials in the war production agencies of the government and the military lacked the knowledge and experience necessary for practical solution of the problems of the industry. This charge appears to have been fully justified by the policies which the government adopted—or failed to adopt—with regard to such decisive matters as supply of labor, materials and equipment, and exercise of authority to promote rationalization.

b. *Coal Control association established.* The second major step in extending centralized control over the mining industry after the formation of the Japan Coal Co. in 1940 was the creation of the Coal Control Association (SEKITAN TOSEI KAI) in November 1941. The TOSEI KAI supplanted the former cartel-like Federation of Coal Mine Owners, and was established as part of the "Economic New Order" program formulated by the Konoye government in December 1940. It was given — on paper — wide powers to encourage efficient practices and to promote rationalization by mergers and pooling of facilities. It set prices to be paid individual producers under the cost-plus subsidy program, and quotas for operators. A chief function was to act as supervisor in allocation and acquisition of materials and labor. Although the avowed purpose of the TOSEI KAI was that it should be the policy-making body for the industry, staffed by experienced mining personnel capable of expressing the industry's point of view in counterbalance to the admittedly bureaucratic ministries, it was in fact never able to exercise a decisive influence on high economic policy, and became progressively more of a subordinate executive agency for carrying out decisions of the Cabinet Planning Board and Mobilization Bureau. Its president was occasionally consulted on policy, but the promised authority never materialized. To what extent this was due to the weakness of the TOSEI KAI's staff is not entirely clear, but it is apparent that few of its demands or recommendations were heeded. The harmonious relations between the industry, the bureaucracy and the military which had been the objective in establishing the TOSEI KAI were never achieved. Interested chiefly in reaching immediate production quotas, the ministries pressed farther the short-range policy of extreme exploitation with the result that mines were flagrantly abused and the quality of the coal deteriorated to such an extent that production figures became misleading. Warnings of the mining engineers were passed over. In line with the general policy of favoring end-products industries and the military forces, adequate measures to supply labor and materials for coal mining were not adopted.

c. *Subsidy program.* Government subsidies to permit fixing of coal prices to consumers and to encourage production had been begun in 1938, and assumed increased importance through the war years. Bonuses were paid in accordance with quotas apportioned by the TOSEI KAI. Operators submitted estimates of their costs to the TOSEI KAI for six-months periods; these estimates, revised after three months in light of actual operating costs, formed the basis of the cost-plus price established for each mine. Until October 1943, price varied with the grade of coal, but thereafter that factor was eliminated, with

an effect on quality which became extremely serious despite policing efforts of the Japan Coal Co. to maintain standards. Total subsidy paid to producers in Japan proper rose from ¥48,194,000 in the first half of 1941 to ¥405,805,000 in the latter half of 1944, although during that period production declined 11.2 per cent (Appendix Table 19). The extent of financial inducement given to spur production of the conveniently situated, but low-quality, lignite of eastern Honshu may be seen in the fact that the average subsidy per ton of coal paid to those producers in the latter half of 1943 was ¥10.06 while that for the far better biuminous of Hokkaido and Kyushu was ¥4.95 and ¥7.41 respectively (Appendix Table 20). When translated into subsidy per million calories, the variation is even more striking (Appendix Table 21). It is noteworthy that—notwithstanding the considerable increase in production costs because of rising wages and black market prices paid for some materials and equipment—the major Japanese mining companies found wartime production highly profitable.

2. *Japan's Wartime Coal Supply*

a. *Decline of domestic production.* After reaching a peak of 57,309,000 tons in 1940, coal production in Japan proper slumped somewhat the following year to 55,602,000 tons. During the next two years the Japanese were able to maintain a fairly consistent rate of production only slightly below the 1941 level. In 1944, however, a sharp drop took place, and the total coal mined fell by 11 per cent to 49,335,000 tons. This downward trend continued into 1945, as the amount produced during the April-June quarter, when converted to an annual rate, declined to 43,508,000 tons. Thereafter, a disastrous collapse occurred. Production in July dropped to 2,712,000 tons and in August to 1,617,000 tons, or less than 20,000,000 tons annually. Data on production by islands disclose that from April 1944 to July 1945 Hokkaido's coal output fell 27.6 per cent, Honshu's 54.8 per cent, and Kyushu's 43.8 per cent (Appendix Table 8).

b. *Causes of decline of production.* (1) *Shortage of skilled coal mining labor.* Ranking very high among the causes of the decline in production in Japan proper in the years from 1941 to 1945 was the critical shortage of strong, experienced mining labor. This problem was by no means the result exclusively of war conditions or government policy, but it was seriously aggravated by both.

TABLE 7.—*Coal production in Japan proper by districts, fiscal years 1940–45*

[In thousands of metric tons]

Years	Hokkaido		Honshu		Kyushu		Total
	Amount of total	Per cent	Amount of total	Per cent	Amount of total	Per cent	
1940	15,378	26.8	8,876	15.5	33,055	57.7	57,30
1941	15,747	28.3	7,993	14.4	31,862	57.3	55,60
1942	15,656	28.9	7,978	14.7	30,544	56.4	54,17
1943	15,647	28.2	8,596	15.5	31,295	56.3	55,53
1944							
I	3,907	29.5	1,973	14.9	7,344	55.6	13,22
II	3,704	30.8	1,855	15.4	6,452	53.8	12,01
III	3,558	28.8	1,752	14.2	7,054	57.0	12,3
IV	3,240	27.6	1,815	15.5	6,681	56.9	11,7
Total	14,409	29.2	7,395	15.0	27,531	55.8	49,3
1945:							
I	3,268	30.0	1,542	14.2	6,067	55.8	10,8
July	947	34.9	314	11.6	1,451	53.5	2,7
August	698	43.2	196	12.1	723	44.7	1,6
Total	4,913	32.3	2,052	13.5	8,241	54.2	15,2

Source: Compiled from data submitted by the Coal Control association (Sekit Tosei Kai), November 1945. Appendix Table 8.

Although the Army and Navy, as well as th planning boards, professed great concern over th coal supply, no effective measures were taken t counteract the movement of essential miners fro the pits. Not only were skilled and unskilled mine called into military service without deferment, bu even specialist technicians were drafted for no specialist duty. A major obstacle to a realistic polic of exemption was the tradition, particularly stron in militarist Japan, that every man is first of all warrior.

By the end of 1942, an estimated 50,000 mine had been taken by the Army alone, and this figu increased by about 10,000 per year in 1943 and 194 During these two years some 4,000 were discharge for various reasons, but the majority, preferring oth work, did not return to the mines. In June 1944, th Army issued orders for the release of some 5,00 miners from troop units stationed in the home island and this number was finally released during the las four months of the year under orders to return t mining. In latter 1944, further conscription of tech nicians was halted, and finally, in early 1945, a conscription of miners was ended.

Furthermore, miners were free to leave the mine for more attractive and better-paid jobs in othe industries. Various government measures controllin movement of workers had little effect. In 1939, th Romu Teicho Law had instituted a requirement tha workers be registered and carry an employment car showing their occupation, and in 1940 the labo adjustment law had applied further restrictions t the hiring and firing of labor. Neither of thes

materially restricted the movement of miners. Coal mining wages were fixed by the wage control laws of 1940–41 and subsequent regulations, and no increase was permitted until 1943, when a 20 to 30 per cent rise was granted. These measures were within the jurisdiction of the welfare ministry. In order to maintain an over-all stabilization, it resisted pressure from the mine operators for higher mining wages and apparently did not appreciate the importance of preserving the mining labor force intact. Attempts of the operators to compensate by furnishing improved living conditions and food were only partially effective.

During 1942 and 1943 a debate on the question of drafting laborers to work in the mines raged in the Tojo cabinet. The premier and the welfare minister opposed demands for more stringent compulsion because of fear of the general unrest which might follow. The Fujiwara cabinet also sidestepped the ss ue.

Meanwhile some relief had been obtained by the employment of Korean contract labor, which, though less efficient, contributed importantly to production. By January 1945 Koreans made up 32 percent of the total labor force. Considerable difficulties were also experienced in the unwillingness of the Koreans to remain in a particular mine. The Army was occasionally called in to "maintain order", and in general no major incident occurred until the end of the war. Koreans were paid the standard wage scale for Japanese miners, and supposedly given equal treatment. A much smaller number of Chinese and prisoner of war labor was used in some of the mines.

By 1944 the coal supply situation had deteriorated to such an extent that a more serious attempt to freeze mining labor was made as coal was put on the list of "essential" industries. Some decline in turnover resulted, but the mines had already lost most of their efficient miners. Even then the law was indifferently enforced, and losses to more attractive types of work continued, in some cases with the connivance of the military who would rob the mines to get labor for construction of airfields and other installations. By this time also, the food production problem approached the critical stage and agricultural labor could no longer be recruited for the mines.

While drastic compulsory measures to supply mining labor were not adopted, a general propaganda campaign based on the patriotic appeal that "coal mining is also in the front line" was launched. This fell rather flat, but a movement to enlist students as part-time workers succeeded in adding several thousands to the employment rolls.

Thus, while the total of those employed by the mining industry increased during the war years, the composition of the labor force changed radically. With this went a drop in efficiency, as shown by annual production per worker of 164 tons in 1941 and 119 tons during 1944.

TABLE 8.—*Composition of coal mining labor force in Japan proper as of end of fiscal years, 1938–44*

[In thousands of persons]

	1938	1939	1940	1941	1942	1943	1944
Japanese, full-time	251	264	293	271	260	242	244
Japanese, part-time	.....	.....	.....	8	13	23	22
Koreans	.....	22	45	61	102	124	135
Chinese	.....	.....	.....	.....	.....	0.5	7.7
Prisoners of war	.....	.....	.....	.....	.....	3.5	7.3
Total	251	286	338	339	375	392	416

Source: Compiled from data supplied by the Coal Control Association (Sekitan Tosei Kai), November 1945.

Appendix table 15 contains a complete analysis of composition and changes in the coal mining labor force by months from April 1941 through April 1945.

(2) *Scarcity of essential mining materials and equipment.* Since 1937, coal producers had encountered increasing difficulty in securing the supplies of steel, cement, and rubber needed to maintain normal operations in the mines. One function of the control association was to represent the industry in obtaining allocation of critical materials, and in executing assignment of available supplies. In general, allocations of materials were far below the industry's requirements; moreover, actual receipts, especially of steel products and cement, rarely measured up to the low allocation figures. Frequently Army and Navy officials made in-roads on even these meager supplies, and operators were forced to resort to the black market for many materials and services.

Closely allied with the lack of materials was the steady deterioration of machinery. Breakdowns and accidents multiplied alarmingly, with disastrous effects on efficiency, and it was impossible in most cases to secure either replacements or the parts for necessary repairs. After 1942 the three major mining machinery manufacturers, Hitachi, Mitsubishi Denki and Yasukawa Denki filled almost no more orders. While some of the major mines were able to carry on with their own repair facilities, most had been dependent for incidental repairs on machine shops which were taken over for armament production. Local trucking and other transportation difficulties seriously delayed maintenance.

The effect of those factors on mine operations is

clearly demonstrated by the experience of the thirteen mines of the Mitsubishi Mining company, as analyzed in the following table. Their history is particularly striking in view of their position in a combine with ample financial resources and their close affiliations with materials and machinery suppliers.

TABLE 9.—*Analysis of operations of 13 mines of Mitsubishi Mining Co., in 1940, producing 13.5 per cent of total coal output in Japan proper, fiscal years 1940–45*

[Index: 1940 equals 100]

Fiscal years	Materials received				Labor employed		Coal production		Average output per employe		Equipment break-downs	
	Rolled steel		Cement									
	Metric tons	Index	Metric tons	Index	End of period	Index	—000 metric tons	Index	Metric tons	Index	Total	Index
1940	10,499	100	11,132	100	37,546	100	7,712	100	205	100	2,631	100
1941	11,916	114	14,567	131	37,193	99	7,808	101	210	102	3,454	131
1942	11,706	112	9,541	86	42,678	114	7,581	98	178	87	4,521	171
1943	6,414	61	10,087	91	43,129	115	7,541	98	175	85	6,000	228
1944	3,030	29	6,457	58	57,763	154	6,710	87	116	57	15,989	608
1945 [1]	4,184	39	4,272	38	51,249	136	2,273	29	44	21	na	na

na indicates figures not available. [1] Partial data converted to annual rate.

Source: Compiled from data submitted to the Coal Control association (Sekitan Tosei Kai) by the Mitsubishi Mining Co., November 1945.

(3) *Long-range effect of abuse of mines.* Beginning as early as 1937, the government demanded maximum immediate production from mine operators. This policy, pursued relentlessly through quotas systems and patriotic appeals, when combined with shortages of skilled labor and materials, led to the abuse of mine properties and neglect of development. More and more workers were taken off maintenance work, and men and materials were diverted to actual digging. Shafts and galleries were neglected; safety standards were set aside.

Representatives of the operators warned of the results of such abuse, but the government persisted in its course. The president of the control association, MATSUMOTO Kenjiro, the most prominent and influential spokesman of the industry, told a Survey interrogator that in 1943 he had delivered to the cabinet the prediction that, unless adequate measures were taken to maintain the mines, they would be so exhausted by the end of 1945 that production would inevitably fall to an annual rate of 15,000,000 to 20,000,000 tons, and that three or four years would then be required to restore production to the 1937 level. He was told that the situation could not be remedied, and that in any event the war would be over before the end of 1945. MATSUMOTO gave a similar warning to the emperor during a special audience; the emperor was described as being "very much disturbed".

(4) *Failure to rationalize coal mining.* In view of the structure of the industry, with a relatively small number of large mechanized mines and a large assortment of small pits working nondescript seams, it is natural to expect that Japan would have attempted to counteract its diminishing supplies of equipment, materials, and skilled labor by concentrating them in the most productive mines yielding the highest quality coal. Although the desirability of such action was freely admitted in official circles—and had in fact been emphasized in the program established for the control association—little was accomplished. No complete study of the situation appears to have been made, and no aggressive policy was adopted. Various difficulties were inherent, and sufficed to prevent any effective rationalization.

Chief among these difficulties were the specific problems of moving workers and equipment. The railways were already overburdened, and methods of moving heavy machinery were primitive and slow. For example, after the submarine threat forced the closing of Hokkaido's Kushiro mines, it was more than a year before its equipment reached the other mines on that island. Miners who were willing to remain in the small pits near home were extremely reluctant to work in large mines, and desertions among those shifted were very high. Japanese labor, with its strong family ties, is remarkably immobile, and difficulties in moving and housing families were considered insuperable. In prewar years the government had fostered the opening of many small independent mines, and was reluctant to exert much pressure to force their closing. Some rationalization was achieved in consolidating neighboring mining rights, and a few instances of amalgamation were carried out.

Stemming from these difficulties, and effectively preventing a comprehensive drive for rationalization, was the belief that its benefits could not be realized

in time to compensate for the loss in immediate production which would be suffered during the period of transfers. The most that was accomplished was a minor diversion of new materials and men to the better mines.

(5) *Effects of air attack on coal mining.* Only two instances of air attack directly on coal mines occurred, both during the final weeks of hostilities. On 31 July and 1 August the surface installations of the three Takashima mines of the Mitsubishi Mining company on the small islands of Hashima and Futago, some seven miles southwest of Nagasaki, were bombed. No account of this attack has been found in any available Allied records. These two raids destroyed the powerhouse and damaged or destroyed many other buildings. Loss of power resulted in flooding one pit so completely that there is no prospect of its being restored. Production at the other two pits was fully stopped, and operations were not expected to be resumed for a minimum of five months, with full capacity unlikely for a minimum of one year. Damage to the installations was assessed at ¥12,000,000, loss of production at ¥10,000,000, and loss of workable coal at 1,750,000 tons. Production of the three mines had totalled 48,000 tons in June and 31,200 in July. The mines offered excellent medium and low-level targets, as the installations were crowded on the small area of the islands.

The second example of direct attack was that of the Miike mine at Omuta, on the eastern shore of Ariake Bay in west-central Kyushu.[1] Here was the largest, and one of the most modern, coal developments in Japan, around which was centered a well-integrated chemical, synthetic fuel, and metal refining complex of prime importance to the nation's war production. The mines extend far under the sea, and are kept from flooding only by continual pumping.

The city of Omuta was subjected to two area incendiary raids, and the high pressure chemical plants to an HE attack. On 18 June, 116 B-29s dropped 785.4 tons of IB from 8,000 feet, burning 0.217 square mile of the built-up area, or 4.1 percent. Burning of power lines halted production at one pit for 18 hours and for six hours at the other three. Production, which had averaged 9,643 tons per day during the first 17 days of June, dropped to a daily average of 7,222 tons during the period 19-30 June.

On 27 July, a second raid of 124 B-29s bombed the city with 964.6 tons of IB from 14,500 feet. This time 2.05 square miles, or about 38 per cent, of the built-up area was destroyed. Surface installations of the mines suffered scattered damage, but the most important result was the burning of several power lines on which the mines depended for pumping. Operations were halted for as long as five days, and widespread flooding of galleries and equipment resulted. Average daily production fell to 3,226 tons for the period 28 July-6 August.

The two raids resulted in putting an estimated 30 per cent of the galleries out of operation for an extended period.

Spillover of a few 1,000 lb. HE bombs from a raid of 17 B-24s directed at the chemical plants caused minor damage to surface installations and a short interruption of power on 7 August.

The urban destruction from the Omuta attacks had a large but indefinable effect on the production of the mines. Operations were further harassed by the almost hourly alerts to which the community was subject during the final days of the war, and by the growing restlessness of the large foreign component among the mine workers.

c. *Drop in imports.* Besides the falling off of domestic production, an equally serious factor affecting the coal position of Japan was the precipitous drop in imports throughout the war years. Shipments from all areas to the home islands, which had risen to an all-time high of 10,123,000 tons in 1940, declined to 9,585,000 tons in 1941 and to 8,748,000 the following year. During 1943 total imports fell by 31 per cent more to 6,029,000 tons, and in the following year slumped to 3,135,000 tons, a drop of 67 per cent from the 1941 level. Detailed figures on wartime imports (Appendix Table 30) disclose the following significant facts:

(1) In the April-July period of 1944, monthly imports averaged about 462,000 tons, or an annual rate of 5,544,000 tons. During the rest of the year the monthly average dropped sharply, falling to about 200,000 tons in the August-December period and to 102,000 tons a month in the final quarter. Shipments during the April-June quarter of 1945 declined still farther to about 63,000 tons per month; they then ceased entirely.

(2) All through the war, shipments from North China-Inner Mongolia made up about 50 per cent of the total coal imports. Since the very existence of the iron and steel industry depended on coking coal from that area, back-breaking efforts were made to maintain that vital supply line. Yet by 1944 deliveries from North China-Inner Mongolia had skidded to 1,515,000 tons, as compared with 4,539,000 tons in 1942. The Army, which controlled most of the ship-

[1] Annex B presents complete available details on these attacks.

ping to and from the continent, urged the iron and steel industry to use poorer coal from Manchukuo—which could move over the shorter, less exposed Japan Sea lanes—but that industry, in its desperation, preferred smaller quantities of the North China coal.

(3) The importance of Karafuto as a source of coal declined steadily after 1941 when exports to Japan Proper came to 3,310,000 tons, or one-third of total coal imports in that year. During 1943 shipments from Karafuto dropped to 1,650,000 tons, but still represented 27 per cent of all coal imports. Deliveries held up fairly well through July 1944; then they dwindled away to a negligible figure in August and September, and stopped entirely thereafter.

Although the Japanese managed to increase coal output in Korea and Manchukuo during the war years, declines in Karafuto and North China-Inner Mongolia brought total production in the four areas during 1944 to 5,700,000 tons under the 1941 total.

TABLE 10.—*Production of coal in Karafuto, Korea, Manchukuo and North China-Inner Mongolia, fiscal years 1941 and 1944.*

[In thousands of metric tons]

Area	1941	1944	Percentage of increase or decrease
Karafuto	6,471	2,678	−58.6
Korea	6,803	7,037	+ 3.4
Manchukuo	24,147	25,627	+ 6.1
North China-Inner Mongolia	23,968	20,333	−15.2
Total	61,389	55,675	−9.3

Source: Compiled from data submitted by the Japan-Manchukuo Trading company (NICHIMAN SHOJI KABUSHIKI KAISHA), the Japan, Manchukuo, China Coal federation (NICHI MANSHI SEKITAN REMMEI), and the Greater East Asia ministry (DAI TOA SHO), November 1945. Appendix Table 7.

Notwithstanding the decline in production in these areas, Japan's inability to maintain imports was solely the result of the transportation crisis. Production in Karafuto was voluntarily reduced to the level of local consumption after the lack of bottoms forced abandonment of coal shipments to Japan proper in the summer of 1944, and a partially successful attempt was made to transfer miners and equipment to collieries in Hokkaido and Honshu.

A second factor which contributed to the slump in coal imports was the increasing difficulty which the Japanese encountered on the continent in moving the coal produced in Manchukuo and North China from the mines to the shipping ports. Interruptions in rail traffic in North China because of air raids and guerrilla activity became so critical by late 1944 that the Army took over their operation. As the volume of available shipping steadily declined, elaborate plans were made to shorten shipping lanes by moving North China and Manchukuoan coal overland t Korean ports. The railway network proved totall unequal to the burden, however, and during 194 coal shipments from North China and Manchuk via the "Korean relay route" amounted to onl 292,000 tons and 422,000 tons respectively, or le than 25 per cent of all imports.

The acute shipping shortage—on which the enti responsibility for the disappearance of vital coal in ports can be pinned—was undoubtedly accentuate by strategic aerial activity. Patrol plane attacks shipping in the Yellow and Japan Seas added to th losses from submarine warfare. The mining campai against continental and Japanese ports carried out April–August 1945 was highly effective in closi many coal-shipping ports for various periods and delaying such shipping as was still available. Bu by the time that campaign got well under way, almost all bottoms were already being used to car top-priority continental foodstuffs and salt. It mu therefore be concluded that while strategic air effor delivered the coup de grace to coal imports, th cumulative shipping shortage was the primary cau of the disastrous decline.

d. *Coal exports.* During the war exports had litt or no effect on the over-all supply situation; by 19 they had shrunk to only 714,000 tons. Shipments non-coking Kyushu coal to bituminous-deficie Korea, largely for railway use, constituted about per cent of total wartime coal exports.

e. *Stocks.* The amount of coal in Japan prop stored at ports, mines, and at dumps along railw lines was periodically recorded by the Japan Coal C Such stocks on 31 March 1942 amounted to 3,326,0 tons, rose to 3,816,000 tons by the end of 1944 and 4,031,000 on 31 March 1945. This reflected direct the increasing difficulty which the Japanese had transporting coal from mines and ports to consume It is clear, however, that transportation difficulti did not become so critical, with but a few min exceptions, as to cause any relaxation in efforts increase production.

At the outset of hostilities stocks of coal on hand consuming centers normally constituted a four-week supply. Those stocks shrank throughout the wa and in early 1945 were sufficient to maintain oper tions for only two weeks. By the end of the war th had practically ceased to exist.

f. *Deterioration of the over-all wartime supply po tion.* The supply of coal available in Japan prop reached its height before Pearl Harbor. In the pea year 1940, the total of (1) stocks at the beginning

the year—1,473,000 tons, (2) production—57,309,000 tons, and (3) net imports—8,632,000 tons, amounted to 67,414,000 tons. The following year, however, saw the beginning of the downward trend in supply which steadily accelerated during 1942-44 and then fell precipitously in the final months of the war. By 1944 the total supply had dropped to 55,572,000 tons; in July 1945, while stocks had risen to 4,036,000 tons, production and net imports were equivalent to an annual rate of only 32,544,000 tons.

TABLE 11.—*Summary of the coal supply position in Japan proper, fiscal years 1940–45*

[In thousands of metric tons]

Period	Stocks at end of previous period	Production	Net imports	Available supply
1940	1,473	57,309	8,632	67,414
1941	1,762	55,602	7,846	65,210
1942	3,326	54,178	7,152	64,656
1943	3,159	55,538	4,929	63,626
1944	3,816	49,335	2,421	55,572
1944:				
I	3,816	13,224	966	18,006
II	3,690	12,011	911	16,612
III	3,910	12,364	454	16,728
IV	4,105	11,736	90	15,931
1945:				
I	4,031	10,877	126	15,034
July	4,036	2,712	----	6,748
August	4,113	1,617	----	5,730

Source: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai) and the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

The drastic reduction in over-all coal supply was naturally felt most keenly in Honshu. Whereas the total amounts available in Hokkaido and Kyushu declined approximately only two per cent and 12 per cent respectively between 1940 and the first quarter of 1945, the supply in Honshu dropped by almost 50 per cent during the same period (Appendix Table 25).

3. *Dislocation of inter-island transportation*

a. *The disruption of water shipments.* In addition to the decline in total supply, Japan's coal position was further complicated by difficulties in distributing the coal which was available. Since at no time during the war did Honshu's output account for more than about one-fourth of the coal consumed on that island, the shipment to Honshu of large quantities of coal from Hokkaido and Kyushu and other Inner Zone areas was the most crucial and, by the Spring of 1945, the most vulnerable link in the Japanese coal traffic.

Early in the war, water transportation—by all types of craft from 10,000-ton colliers to small motor-sailers—handled the great bulk of the coal delivered to Honshu. Kyushu coal consumed in its industrial centers was moved eastward through the Inland sea to Osaka-Kobe, and to the Tokyo bay area. Hokkaido coal was shipped down the Pacific coast. After 1942, however, the importance of sea transportation in inter-island coal traffic declined steadily. Whereas, in that year, water movement accounted for practically all inter-island coal shipments, during 1944 the volume moving by sea had dropped by 45 per cent from the 1942 level and amounted to only about 60 per cent of the total transported in 1944. By the end of June 1945, sea shipments accounted for less than half of the total inter-island movement of coal.

TABLE 12.—*Inter-island coal shipments to Honshu by sea, fiscal years 1941–45*

[In thousands of metric tons]

Year	From Hokkaido	From Kyushu	Total	Percentage of all coal shipped
1941	7,316	13,379	20,695	97.8
1942	8,071	12,056	20,127	91.1
1943	6,192	10,136	16,328	76.5
1944	4,481	6,638	11,119	61.5
1945:				
April	458	367	825	60.7
May	460	260	720	54.5
June	259	191	450	45.9
July	275	189	464	54.6
Total	1,452	1,007	2,459	54.5

Source: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai) and the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

The cumulative deterioration of Japan's shipping position was undoubtedly the chief factor contributing to the marked drop in inter-island sea shipments of coal which occurred between 1942-44. Intensification of Allied submarine activity during 1943 and 1944 caused a sharp drop in the volume of coastal shipments from Hokkaido. In March 1944, for example, total Hokkaido coal arrivals by sea at Tokyo, Yokohama and Kawasaki had been reduced to about 20 per cent of the monthly average maintained August-December 1942. By the end of 1944, they had almost disappeared (Appendix Table 24).

With Tokyo bay thus practically closed to large shipping, the Japanese sought to employ an alternate sea lane to rear-Honshu ports on the Japan sea. Unloading facilities at these harbors were so lamentably meager and poorly organized, however, that the expected diversion could not be handled. The government failed to take action in improving conditions; at times as many as thirty vessels were held waiting their turn at the congested wharves at a single port. In December 1943, an experienced engineer and former chief of the Mitsui Coal depot at Kawasaki, realizing the necessity of increasing the unloading

capacity of the rear-Honshu ports and impatient with the government's failure to take any action, undertook on his own initiative a survey of the facilities at those ports and submitted a comprehensive report of his findings to the government. A translation of his report is available in the survey files. He stated that, although his survey was submitted early in 1944, more than a year elapsed before the government took any steps to correct the situation. By that time, of course, it proved impossible to assemble the necessary machinery, and, when the war ended in August, no improvement had yet been accomplished.

Allied air power did not reach the inter-island shipping lanes until after the start of 1945. The disastrous collapse in water transportation which took place in the final months of the war did, however, result in large part from highly successful strategic air action. The mine laying program and the anti-shipping forays in the Moji-Shimonoseki straits, the Inland sea, and ports on the Japan sea, which were carried on with ever-increasing intensity after March 1945, aided substantially in reducing total sea shipments from 825,000 tons in April to 464,000 tons in July. Particularly hard hit by such efforts were the coal shipments moving through the Inland sea from Kyushu. Prior to 1945, such wartime deliveries had held above a monthly level of 400,000 tons. Yet during April and May they dropped to 367,000 tons and 260,000 tons respectively and in July sank to 189,000 tons. By that time, even the important industrial center and shipping terminus of Osaka was entirely dependent on the railways for its coal supplies

b. *Increasing importance of railway shipments.* As the problems of sea transportation multiplied, the Japanese resorted more and more to the railway system for delivery of the coal so urgently needed by consumers in the industrial centers of Honshu. This was made possible chiefly by two developments: (1) the opening of the Kammon tunnel in September 1942, which provided the first direct rail connection between Honshu and Kyushu; and (2) the increase in the number of special train ferries between Hakodate in southern Hokkaido and Aomori in northern Honshu from seven in 1941 to twelve in June 1945.

During the fiscal year 1941, of the 7,329,000 tons of coal shipped from Hokkaido to Honshu only 13,000 went by rail, and only 444,000 (by ferry across Shimonoseki straits) of the 13,823,000 tons transported from Kyushu, for a total of only 2.2 per cent of all coal moved from those islands to Honshu. In the fiscal year 1942, during half of which the Kammon tunnel was in operation, rail shipments accounted for less than ten per cent of such coal movement. In June 1945, rail shipments of such coal amounted to 54.1 per cent of the total.

TABLE 13.—*Inter-island coal shipments to Honshu by rail, fiscal years 1941–45*

[In thousands of metric tons]

Year	From Hokkaido	From Kyushu	Total	Percentage of all coal shipped
1941	13	444	457	2.2
1942	117	1,860	1,977	8.9
1943	602	4,402	5,004	23.5
1944	1,434	5,537	6,971	38.5
1945:				
April	118	416	534	39.3
May	135	467	602	45.5
June	138	393	531	54.1
July	75	311	386	45.4
Total	466	1,587	2,053	45.5

Source: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai) and the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

Considerable difficulties had to be overcome, however, in accommodating handling procedures to this shift from the traditional maritime system. At major consumption centers like Tokyo-Yokohama and Osaka-Kobe, much of the coal had formerly either been unloaded directly from colliers at the consuming plants or had been lightered through canals. The change-over to rail delivery called for make-shift adaptations of unloading equipment and drastically revised routines.

It is noteworthy that this revolutionary change in the coal traffic pattern was accomplished in three years under chaotic war conditions without causing either cutbacks in production or the piling up of large stocks awaiting shipment. Although this period of increasing dependence on rail transport also saw a decline of 16 per cent in total coal production in Japan proper and a reduction of 3,950,000 tons in total movement from the other islands to Honshu, it is clear that the production decrease resulted from conditions other than inability to ship mined coal. The push for maximum production was not only never relaxed on this account, but was continually intensified. Stocks awaiting shipment at mines and ports rose only from 3,326,000 tons at the end of 1944 to 4,031,000 tons by 31 March 1945, an increase representing merely 1.4 per cent of the 1944 production figure.

The concentration of Japanese rail traffic over a few lines with many tunnels and bridges, and the fact that all coal moving by rail to Honshu had to funnel through the bottleneck ferries and tunnel, made this traffic highly vulnerable to attack. Carrier-based

strikes in July and August, by sinking the rail ferries, eliminated the direct rail traffic from Hokkaido; the Kyushu traffic suffered only indirectly as a result of urban area attacks and general deterioration of the rail system.

4. *Wartime consumption pattern*

a. *Effects of the reduction in supply and the dislocation of transportation.* The paralyzing decline in Japan's coal supply was clearly reflected in the war time consumption pattern. By 1944, the 47,471,000 tons of coal consumed in that year (excluding the quantity used at the mines) was 21 per cent below the 1941 level. During each quarter of 1944 and the first quarter of 1945, the rate of consumption fell steadily. The completeness of the collapse in the coal supply position in Japan proper which occurred in the final months of the war is clear from the fact that the 2,268,000 tons consumed in July 1945 represented only about half the quantity of coal used in June 1944 and approximately one-third less than the amount consumed in April 1945.

TABLE 14.—*Coal consumed in Japan proper, excluding the amount used at the coal mines, fiscal years 1941–45*

[In thousands of metric tons]

Year	Amount consumed
1941	60,140
1942	58,797
1943	56,709
1944:	
I	13,349
II	12,233
III	11,266
IV	10,623
Total	47,471
1945:	
April	3,331
May	3,346
June	2,859
July	2,268
Total	11,804

Source: Compiled from data supplied by the Japan Coal company, (Nihon Sekitan Kaisha), November 1945.

Honshu, which used more than half of all the coal consumed in Japan proper, naturally experienced the most severe effects from the combination of reduced production and transportation difficulties. Data on the volume of coal consumed in the various island districts (excluding the amount used by the railways and at coal mines), disclose that during the April-June quarter of 1945 the rate of consumption in Honshu had dropped 47 per cent below the level maintained in the April-June quarter of the previous year. Coal consumption in Hokkaido and Kyushu, on the other hand, fell off by only 13 per cent and 22 per cent respectively during the same period.

TABLE 15.—*Coal consumption in Japan proper by districts, excluding use by railways and at coal mines, fiscal years 1944–45.*

[In thousands of metric tons]

Year	Hokkaido	Eastern Honshu	Western Honshu	Kyushu	Total
1944:					
I	1,547	3,034	3,482	3,344	11,407
II	1,789	2,744	3,048	2,692	10,273
III	1,365	2,138	3,030	2,789	9,322
IV	1,087	1,794	2,575	2,927	8,383
Total	5,788	9,710	12,135	11,752	39,385
1945:					
I	1,344	1,474	1,977	2,596	7,391
July	443	281	371	602	1,697
Total	1,787	1,755	2,348	3,198	9,088

Source: Compiled from data submitted by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

b. *The allocation system.* The government tried to make the constantly dwindling supply of coal go as far as possible by tightening up the allocation system. Allocations by the Ministry of Munitions, which had normally been planned semi-annually, were changed late in 1944 to a quarterly basis. As those plans were always based on an over-estimated supply, actual distribution became a matter of ever-changing priority allotments against a background of unfilled allocations. The Army and Navy, the railroads, and at times the electric power system, had over-riding priorities. Other industries scrambled to divide what was left.

Under the allocation system, individual users submitted estimates of volume requirements and quality to the Japan Coal company, the agency having sole control over the distribution of supply. The company, in turn, apportioned the available supply in accordance with the over-all allocation plan formulated by the Munitions ministry. Quality specifications had to be largely ignored. Deliveries to consumers were made not through a ticket system, but by direct allotment. Toward the end of the war, the confusion which developed from the steady decline of domestic production and the dislocation of transportation became so acute that consumers rarely knew how much coal to expect—or of what sort—until deliveries had actually been received. The inadequate records of the Japan Coal company make it impossible to measure accurately the success of the allocation system, but information on allocations to industries and districts, together with a comparison of amounts allocated and consumed by industrial consumers, appears in Appendix Tables 38-39.

e. *Changes in pattern of industrial consumption.* By 1944, all major consumers, with the exception of the railways and the industries manufacturing liquid fuel and machinery, were using substantially less coal than they had in 1941. The following table sets forth comparative data on the amounts of coal used during 1941 and 1944 by the eight consumer categories which were the largest in the latter year:

TABLE 16.—*Comparison of selected major consumers of coal in Japan proper, during fiscal years 1941 and 1944*

[In thousands of metric tons]

Industry	Consumed in 1941	Consumed in 1944	Percentage increase or decrease
Iron and steel	13,171	11,241	−15
Railways	5,105	8,086	+58
Chemical	6,572	4,715	−28
Electric power	4,202	3,705	−12
Gas and coke	4,080	3,358	−18
Machinery manufacture	1,931	2,179	+13
Ceramics, including cement	3,779	2,029	−46
Non-industrial heating and cooking	3,361	2,026	−40

Source: Compiled from data submitted by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

The relative importance of individual industrial consumers, in terms of the percentage of total consumption, shifted only slightly until the last months of the war. A comparison of the eight largest consumers in 1944 with a similar ranking for 1941, for example, discloses that only one of the industries included in the earlier year, the fibre and textile industry, does not appear in the later group. Railway coal consumption, however, did increase greatly and during the April-June quarter of 1945 the railroads and the iron and steel industry accounted for almost half of the total coal used.

The quantitative data on coal consumption contained in the preceding sections do not, however, accurately mirror the extent of the catastrophe which engulfed the Japanese economy. As the war progressed and as mining conditions worsened with each successive year, the quality of the coal actually delivered to consumers deteriorated steadily. Thus, ever-increasing quantities of coal had to be burned to provide a volume of energy equivalent to that which had been produced in earlier years with substantially less coal. Faced with a rapidly diminishing supply of poorer and poorer quality coal, Japanese industry was brought almost to a standstill. The percentage of under-utilized industrial capacity shot upward; the number of plant shutdowns multiplied; locomotives functioned badly on inferior fuel. The end of hostilities found Japan tightly clutched in the grip of widespread economic paralysis.

TABLE 17.—*Relative consumption of coal by selected industries in Japan proper, in percentages of total consumption, fiscal years 1941–45*

Industry	1941	1942	1943	1944	Apr-July 1945
Railroads	8.5	10.7	12.3	17.0	23.2
Iron and steel	21.9	22.7	24.2	23.7	20.7
Chemical	10.9	9.9	10.9	9.9	9.0
Electric power	7.0	8.9	9.0	7.8	5.0
Gas and coke	6.8	6.7	6.7	7.1	4.3
Shipbuilding, machinery manufacture, metal mining and refining	5.1	5.1	5.5	6.8	6.7
Ceramics, including cement	6.3	5.9	5.2	4.3	4.3
Non-industrial heating and cooking	5.6	4.1	3.8	4.3	4.8
Total	72.1	74.0	77.6	80.9	78.0

Sources: Compiled from data submitted by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

V.

CONCLUSIONS

1. *Strategic significance of the coal supply*

The selection of targets for the strategic air effort against Japan was influenced by the belief that coal, a basic raw material, lay deep in the Japanese war economy, and that any disruption of the coal supply would adversely affect the availability of end-products only after a considerable time lag. It was consequently assumed that Allied air strength would be most profitably used in direct attacks on end-products industries.

It is clear, however, that coal did not in fact occupy so remote a position in the economy as was supposed. Japan began the war with an end-products capacity disproportionately large in relation to her inadequate supply of basic raw materials, including coal. During the war, this disparity was increased by her own policies and by the blockade, despite a reduction in end-products capacity resulting from direct attack. Throughout the war years, the coal supply position steadily deteriorated as domestic production capacity fell off and vital imports were strangled. By early 1945 the diminishing supply was spread so thin that any serious further dislocation would have had a profound—and immediate—effect on the entire economic structure.

The whole fabric of Japan's war production was, n fact, stretched far tighter than most Allied strate- ists had assumed, and the relationship of the coal upply to the nation's war-making ability was much loser than had generally been believed. Cutting off oal imports effectively canceled all but a small ortion of the iron and steel industry, regardless of ther factors; innumerable industries were geared to he use of coal for fuel and power, either directly or hrough gas; much of the electric power supply was erived from coal, especially in the dry season. Most nportant, perhaps, was the almost total dependence f the railway system on coal for motive power, and, n turn, the dependence of the entire economy on hat means of transportation for production, recu- eration and for mobility of stocks in its industrial nd manpower reservoirs.

. *Direct attacks on coal production not feasible*

Direct attacks on coal mining facilities would not ave provided the most efficient method of effecting ich a dislocation. In the final months of the war, r activity over Kyushu did contribute to a drop in oduction by (1) damaging the power supply re- uired for essential pumping operations at the Miike nd Takashima fields and (2) undermining the morale nd efficiency of the workers. By the time those raids ok place, however, the cumulative effect of the her production factors was already taking its toll. oreover, Japan's coal production capacity involved many separate mines—and destruction of the tal installations would have required so precise an tack—that any substantial reduction in coal output that method would at best have been a long and stly undertaking.

Extreme vulnerability of coal transportation

Clearly the most vulnerable target in Japan's coal mplex was its transportation. By June 1945, the ipping shortage and the interference with sea lanes d already practically cut off all imports of coal. Inter-island movement of coal to Honshu by water routes had been reduced to only slightly more than one-fourth of the 1942 volume, resulting in an acute dependence on railways. The character of the rail- way system in Japan proper and the fact that all coal going by rail to Honshu had to funnel through the Hakodate-Aomori rail ferries and the Kammon tun- nel made this traffic highly vulnerable to Allied attack. A concentrated campaign against Japan's sea and rail transportation system thus offered the logical method of further reducing her coal supply, with resultant general paralysis of industrial activity and virtual immobilization of her remaining resources. Had such a campaign been feasible operationally, it might well have resulted in an earlier and more destructive blow to Japan's economy than could be achieved with similar effort in attacks on end- products industries.

APPENDIX TABLE 1.—*Coal mined, and reserves remaining, in Japan proper, by fields and type*

[In millions of metric tons]

Field	Type	Amount mined before 1 April 1945	Known remaining deposit
Hokkaido			
Ishikari	Bituminous	251	2,804
Kushiro	do	26	287
Others	do	13	551
Total Hokkaido		290	3,642
Honshu			
Joban	Lignite	125	410
Ube	Lignite and anthracite	109	627
Others	Lignite and anthracite	5	59
Total Honshu		239	1,096
Kyushu			
Chikuho	Bituminous	700	2,553
Kasuya	do	52	170
Miike	do	116	231
Saga	do	79	258
Hokusho	do	57	665
Nishisonoki	do	78	221
Others	do	23	351
Total Kyushu		1,105	4,449
Total Japan proper		1,634	9,187

Source: Compiled by the Fuel Bureau, Ministry of Commerce and Industry, November 1945

APPENDIX TABLE 2.—*Coal production in Japan proper, by districts and size of mines, fiscal years 1932–44*

[Production in thousands of metric tons]

	1932		1933		1934		1935		1936		1937	
	Number of mines	Production	Number of mines	Production	Number of mines	Production	Number of mines	Production	Number of mines	Production	Number of mines	Production
Hokkaido												
Less than 50,000 tons	29	184	40	221	40	246	40	390	42	240	38	224
50,000 to 150,000 tons	13	1,251	12	1,180	12	1,142	10	1,049	11	1,099	13	1,372
150,000 to 300,000 tons	9	2,152	8	1,916	8	1,850	9	2,080	9	2,076	6	1,310
More than 300,000 tons	4	2,467	6	3,749	7	4,389	7	4,799	9	5,873	12	7,824
Total	55	6,054	66	7,066	67	7,627	66	8,318	71	9,288	69	10,730
Eastern Honshu												
Less than 50,000 tons	55	25	57	252	75	381	77	535	79	609	86	693
50,000 to 150,000 tons	7	486	9	680	8	670	5	577	5	507	6	624
150,000 to 300,000 tons	1	161	1	202	1	230	1	265	2	451	1	153
More than 300,000 tons	3	1,448	2	1,188	2	1,342	2	1,282	2	1,359	3	1,544
Total	66	2,120	69	2,322	86	2,623	85	2,659	88	2,926	96	3,014
Western Honshu												
Less than 50,000 tons	15	10	22	12	22	13	15	12	72	391	73	43
50,000 to 150,000 tons									2	80	3	36
150,000 to 300,000 tons									2	403	2	47
More than 300,000 tons									2	2,065	2	1,864
Total	15	10	22	12	22	13	15	12	78	2,939	80	3,030
Kyushu												
Less than 50,000 tons	157	1,619	186	1,266	218	1,631	203	1,550	179	2,450	180	2,054
50,000 to 150,000 tons	30	2,973	35	3,551	33	3,286	34	3,144	28	2,690	30	2,994
150,000 to 300,000 tons	21	4,316	17	3,817	17	3,491	20	4,065	17	3,663	18	3,972
More than 300,000 tons	17	10,961	22	14,490	27	17,254	27	18,014	26	17,847	26	19,454
Total	225	19,869	260	23,124	295	25,662	284	26,773	250	26,650	254	28,474
Total Japan proper												
Less than 50,000 tons	256	1,838	305	1,751	355	2,271	335	2,487	372	3,690	377	3,404
50,000 to 150,000 tons	50	4,710	56	5,411	53	5,098	49	4,770	46	4,376	52	5,253
150,000 to 300,000 tons	31	6,629	26	5,935	26	5,571	30	6,410	30	6,593	27	5,913
More than 300,000 tons	24	14,876	30	19,427	36	22,985	36	24,095	39	27,144	43	30,687
Total	361	28,053	417	32,524	470	35,925	450	37,762	487	41,803	499	45,257

	1938		1939		1940		1941		1942		1943		1944	
	Number of mines	Production	Number of mines	Production	Number of mines	Production	Number of mines	Production	Number of mines	Production	Number of mines	Production	Number of mines	Production
Hokkaido														
Less than 50,000 tons	53	310	68	403	85	717	65	742	54	590	24	303	13	3
50,000 to 150,000 tons	11	1,042	14	1,254	14	1,360	18	2,015	17	1,823	15	1,477	13	1,2
150,000 to 300,000 tons	8	1,674	12	2,601	11	2,278	9	1,915	12	2,628	13	1,928	10	2,2
More than 300,000 tons	13	9,309	12	9,325	15	11,023	15	11,075	15	10,617	16	11,940	13	10,5
Total	85	12,335	106	13,583	125	15,378	107	15,747	98	15,658	68	15,648	49	14,4
Eastern Honshu														
Less than 50,000 tons	93	622	99	774	120	864	133	789	126	816	141	877	117	9
50,000 to 150,000 tons	6	540	8	556	10	941	9	845	10	1,056	9	977	7	5
150,000 to 300,000 tons	1	165	3	530	2	461	2	406	2	494	3	581	2	4
More than 300,000 tons	3	1,859	3	1,759	3	1,748	3	1,417	3	1,504	2	1,635	2	1,3
Total	103	3,186	113	3,619	135	4,014	147	3,457	141	3,870	155	4,070	128	3,4
Western Honshu														
Less than 50,000 tons	86	512	85	682	92	965	101	988	101	947	88	744	81	8
50,000 than 150,000 tons	3	211	9	744	10	874	9	896	11	986	13	1,016	9	7
150,000 to 300,000 tons	2	345	1	197	2	349	1	163	1	263	4	842	3	6
More than 300,000 tons	3	2,350	3	2,573	3	2,674	3	2,489	2	1,912	2	1,924	2	1,7
Total	94	3,418	98	4,196	107	4,862	114	4,536	115	4,108	107	4,526	95	3,9
Kyushu														
Less than 50,000 tons	222	1,978	225	2,197	244	2,840	315	2,780	250	2,420	197	2,949	95	1,9
50,000 to 150,000 tons	30	2,789	37	3,615	39	3,952	42	4,024	47	4,320	46	4,751	40	3,2
150,000 to 300,000 tons	16	3,604	18	3,765	22	4,749	21	4,551	22	4,935	17	2,903	22	4,8
More than 300,000 tons	28	21,374	26	21,434	24	21,514	25	20,510	23	18,868	27	20,692	21	17,2
Total	296	29,745	306	31,011	329	33,055	403	31,862	342	30,543	287	31,295	178	27,5
Total Japan proper														
Less than 50,000 tons	454	3,422	477	4,056	541	5,386	614	5,299	531	4,773	450	4,873	306	4,1
50,000 to 150,000 tons	50	4,582	68	6,169	73	7,127	78	7,777	85	8,185	83	8,221	69	6,1
150,000 to 300,000 tons	27	5,788	34	7,093	37	7,837	33	7,035	37	8,319	37	6,254	37	8,1
More than 300,000 tons	47	34,892	44	35,091	45	36,959	46	35,491	43	32,902	47	36,191	38	30,5
Grand total	578	48,684	623	52,409	696	57,309	771	55,602	696	54,179	617	55,539	450	49,3

Source: Compiled by the Coal Control association (Sekitan Tosei Kai), November 1945.

APPENDIX TABLE 3.—*Coal mines opened and reopened in Japan proper, by districts and by size of expected annual production, fiscal years 1931–44*

[In metric tons]

	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944
Hokkaido														
Less than 50,000 tons[1]	10	3	8	14	15	9	30	23	4	2	1	1		
50,000 to 150,000 tons							5	3	1	1	3			
150,000 to 300,000 tons		1					2	3	1	2	1			1
More than 300,000 tons									1					
Eastern Honshu														
Less than 50,000 tons[1]	11	9	10	16	19	10	14	29	9	8	10	5	1	2
50,000 to 150,000 tons				2	1	1	2							
150,000 to 300,000 tons														
More than 300,000 tons														
Western Honshu														
Less than 50,000 tons[1]	9	5	19	13	7	12	9	24	1	7	5	5	7	2
50,000 to 150,000 tons	1	1	1		1	6		4						
150,000 to 300,000 tons														
More than 300,000 tons														
Kyushu														
Less than 50,000 tons[1]	26	13	18	34	29	35	17	45		3		2	3	
50,000 to 150,000 tons		1	1	1	1	2	1	5	1	5	3	2	7	3
150,000 to 300,000 tons					1	1		1			1		1	
More than 300,000 tons														
Total Japan proper														
Less than 50,000 tons[1]	56	30	55	77	70	66	70	121	14	20	16	13	11	4
50,000 to 150,000 tons	1	2	2	3	3	9	8	12	2	6	6	2	7	3
150,000 to 300,000 tons		1			1	1	2	4	1	2	2		1	1
More than 300,000 tons									1					
Grand total	57	33	57	80	74	76	80	137	18	28	24	15	19	8

[1] "Insignificant mines" are included in years 1931–1938, but omitted thereafter.

Source: Compiled by the Fuel Bureau, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 4.—*Number and capacity of coal mines closed in Japan proper by districts, fiscal years 1941–47*[1]

[In thousands of metric tons]

Year	Reasons for closing	Hokkaido		Eastern Honshu		Western Honshu		Kyushu		Total	
		Number	Capacity	Number	Capacity	Number	Capacity	Number	Capacity	Number	Capacity
1941		10	na	11	na	4	na	65	na	90	na
1942		30	na		na	13	na	55	na	98	na
1943	For poor quality	8	81	5	21			8	75	21	177
	For excessive cost	10	150	12	32	6	147	70	646	98	975
	For exhaustion of seam	29	63	3	2	8	12	75	168	115	245
	Total	47	294	20	55	14	159	153	889	234	1,397
1944	For lack transport[2]	6	525							6	525
	For excessive cost							1	26	1	26
	Total	6	525					1	26	7	551
1945	For poor quality							2	28	2	28
	For excessive cost							na	292	na	292
	For exhaustion of seam					1	42	na	16	na	58
	Total					1	42	na	336	na	378

na Indicates data not available.

[1] "Capacity" is production of last full year before closing. Data in this table are the best available from extant records at the source, but are admittedly incomplete. The source estimates that of mines closed prior to 1943, more than 90 per cent had a production of less than 3,000 metric tons. It is estimated that 60 percent of the closings resulted from poor quality, low quantity, and unprofitable operation; 30 per cent resulted from exhaustion of the seam; 10 per cent from damage through flooding, explosion, etc. Prior to December 1941, operators were free to close mines on their own volition. Thereafter the decision rested with the government.

[2] The only significant instance of closing because of lack of transportation was that of the mines in the Kushiro field, which had been dependent solely on shipping along the exposed east coast of Hokkaido.

Source: Compiled by the Fuel Bureau, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 5.—*Coal production in Japan proper, by major companies and associations of minor companies, fiscal years 1931–44.*

[In thousands of metric tons]

	1931	1935	1941	1942	1943	1944
Major companies						
Mitsui Mining Co.	3,978	5,504	9,202	9,096	9,577	9,684
Mitsubishi Mining Co.	3,115	3,873	7,834	7,578	7,584	6,710
Hokkaido Tanko-kisen Co.	2,497	3,059	4,958	4,972	5,179	5,280
Sumitomo Mining Co.	1,301	1,451	2,202	2,177	2,228	2,255
Ube-kosan Co. (Okinoyama)	839	1,154	1,263	1,076	1,173	2,054
Nittetsu Mining Co.	1,195	1,450	1,803	1,644	1,819	1,679
Meiji Mining Co.	1,199	1,302	1,824	1,853	1,882	1,607
Kaijima Coal Mine Co.	1,393	1,870	2,097	1,958	1,876	1,590
Furukawa Mining Co.	475	907	1,671	1,499	1,487	1,403
Nippon Mining Co.	.....	746	1,675	1,430	1,542	1,205
Joban Coal Mine Co.	1,056	937	488	639	624	1,197
Aso Mining Co.	772	1,063	1,204	1,129	1,204	1,049
Kishima Coal Mine Co.	520	612	1,007	953	975	815
Yubetsu Tanko-tetsudo Co.	236	554	1,455	1,345	1,314	742
Toho Coal Mine Co.	261	382	900	769	753	518
Koho Mining Co.	171	311	321	340	401	384
Taisho Mining Co.	406	642	271	335	368	289
Showa Denko Co.	.....	.....	328	282	238	279
Taiheiyo Coal Mine Co.	292	392	1,043	971	921	266
Daniboo Coal Mine Co.	138	249	237	230	295	247
Higashimisome Coal Mine Co.	385	687	912	837	751	.....
Iriyama Saitan Co.	385	538	652	647	592	.....
Total	20,614	27,683	43,347	41,760	42,777	39,253
Percentage of total production	73.6	73.3	78.0	77.1	77.0	79.6
Associations of minor companies (Tosei Kumiai), by districts						
Kita-kyushu	na	na	4,413	4,587	4,713	3,726
Nishi-kyushu	na	na	2,862	2,676	2,757	2,326
Yamaguchi	na	na	1,985	1,851	2,221	1,783
Tohoku	na	na	1,065	1,139	1,188	858
Hokkaido	na	na	1,283	1,256	892	703
Tohu	na	na	644	826	892	582
Seibu	na	na	63	84	99	104
Total	7,373	10,079	12,255	12,419	12,762	10,082
Grand total	27,987	37,762	55,602	54,179	55,539	49,335

na Indicates data not available.

Source: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai), November 1945.

APPENDIX TABLE 6.—*Summary of the coal position in Japan proper, fiscal years 1931–45*

[In thousands of metric tons]

Year	Production	Imports	Exports	Production plus net imports	Consumption [1]	Stocks at end of year
1931	27,987	3,110	1,983	29,114	na	1,376
1932	28,053	3,271	1,847	29,477	na	1,237
1933	32,524	4,275	2,128	34,671	[2] 31,466	944
1934	35,925	5,072	1,676	39,321	[2] 35,168	657
1935	37,762	5,381	1,765	41,378	42,707	698
1936	41,803	6,163	1,988	45,978	47,245	1,128
1937	45,258	6,360	1,904	49,714	51,157	1,038
1938	48,684	6,893	1,725	53,852	55,313	1,145
1939	52,409	8,285	1,689	59,005	61,254	1,473
1940	57,309	10,123	1,491	65,941	66,542	1,762
1941	55,602	9,585	1,739	63,448	63,055	3,326
1942	54,178	8,748	1,596	61,330	61,992	3,159
1943	55,538	6,029	1,100	60,467	59,740	3,816
1944	49,335	3,135	714	51,756	50,471	4,031
1945:						
I	10,877	188	62	11,003	9,536	4,036
II	5,238	.....	.....	5,238	5,050	3,731

na Indicates data not available.

[1] Attention is called to the fact that the figures in the above table do not balance and that in some years the amount consumed is actually greater than the supply available. The data used were furnished by two different Japanese agencies, the Coal Control association and the Japan Coal company, which, in turn, secured their statistics from many different sources. Although several interviews with responsible officials failed to reconcile the obvious discrepancies existing in the data, the officials stated that the figures on consumption undoubtedly overstated the amounts of coal actually used.

[2] Coal consumed at coal mines not included.

Sources: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai) and the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 7.—*Coal production, fiscal years 1938–44*

[In thousands of metric tons]

Year	Japan proper	Karafuto	Korea	Manchukuo	Formosa	North China-Inner Mongolia	Central China	Total
1938	48,684	3,435	3,419	15,988	2,199	9,959	na	na
1939	52,409	4,993	5,171	19,496	2,608	15,272	na	na
1940	57,309	6,465	6,096	21,132	2,827	17,966	469	112,264
1941	55,602	6,471	6,803	24,147	2,770	23,968	795	120,556
1942	54,178	4,916	6,645	24,169	2,311	24,878	929	118,026
1943	55,538	4,979	6,574	25,390	2,324	21,735	878	117,418
1944	49,335	2,678	7,037	25,627	1,653	20,333	874	107,537

na Indicates data not available.

Sources: Figures for Japan proper compiled from data submitted by the Coal Control association (Sekitan Tosei Kai); figures for production in other areas compiled from data submitted by the Japan-Manchukuo Trading company (Nichiman Shoji Kabushiki Kaisha), the Japan, Manchukuo, China Coal federation (Nichi Manshi Sekitan Remmei), and the Greater East Asia ministry (Dai Toa Sho), November 1945.

APPENDIX TABLE 8.—*Production of coal in Japan proper, by islands, fiscal years 1931–45*

[In thousands of metric tons]

Year	Hokkaido	Eastern Honshu	Western Honshu	Total Honshu	Kyusbu	Grand total
1931	6,134	2,353	1,826	4,179	17,674	27,987
1932	6,055	2,120	1,888	4,008	17,990	28,053
1933	7,066	2,322	2,295	4,617	20,841	32,524
1934	7,627	2,623	2,687	5,310	22,988	35,925
1935	8,318	2,659	2,625	5,284	24,160	37,762
1936	9,288	2,926	2,939	5,865	26,650	41,803
1937	10,730	3,016	3,038	6,054	28,474	45,258
1938	12,335	3,186	3,418	6,604	29,745	48,684
1939	13,583	3,619	4,196	7,815	31,011	52,409
1940	15,378	4,015	4,861	8,876	33,055	57,309
1941:						
I	3,967	860	1,112	1,972	8,463	14,402
II	3,797	679	1,034	1,713	7,226	12,736
III	3,984	850	1,130	1,980	7,831	13,795
IV	3,999	1,068	1,260	2,328	8,342	14,669
Total	15,747	3,457	4,536	7,993	31,862	55,602
1942:						
I	3,671	872	1,013	1,885	7,344	12,900
II	3,705	898	826	1,724	6,570	11,998
III	4,079	947	1,030	1,977	7,917	13,973
IV	4,201	1,153	1,239	2,392	8,713	15,306
Total	15,656	3,870	4,108	7,978	30,544	54,177
1943:						
I	3,882	938	1,050	1,988	7,655	13,525
II	3,708	951	992	1,943	7,073	12,724
III	3,910	1,018	1,181	2,199	7,836	13,945
IV	4,147	1,163	1,303	2,466	8,731	15,344
Total	15,647	4,070	4,526	8,596	31,295	55,531
1944						
April	1,308	320	375	695	2,580	4,583
May	1,333	305	372	677	2,532	4,541
June	1,266	268	333	601	2,232	4,099
July	1,292	289	339	628	2,185	4,105
August	1,192	297	317	614	2,113	3,919
September	1,226	288	325	613	2,154	3,993
October	1,152	322	315	637	2,247	3,936
November	1,177	255	318	573	2,276	4,026
December	1,229	287	355	642	2,537	4,409
January	1,004	309	310	619	2,318	3,941
February	988	282	286	568	2,080	3,636
March	1,248	310	318	628	2,283	4,159
Total	14,409	3,432	3,963	7,395	27,531	49,335
1945						
April	1,050	239	275	514	2,037	3,601
May	1,091	243	288	531	2,093	3,715
June	1,127	207	290	497	1,937	3,561
July	947	167	147	314	1,451	2,712
August	698	92	104	196	723	1,617
September	452	75	32	107	350	909
Total	5,365	1,023	1,136	2,159	8,591	16,115

Source: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai), November 1945.

APPENDIX TABLE 9.—*Production of coal in Japan proper, by 10-day periods, April–September 1945* [1]

[In thousands of metric tons]

Month	Hokkaido	Eastern Honshu	Western Honshu	Total Honshu	Kyushu	Grand total
April						
1st period	337	69	72	141	626	1,104
2nd period	332	75	69	144	680	1,156
3rd period	362	78	90	168	680	1,210
Total	1,031	222	231	453	1,986	3,470
May						
1st period	349	66	73	139	645	1,133
2nd period	335	74	79	153	632	1,120
3rd period	404	83	91	174	730	1,308
Total	1,088	223	243	466	2,007	3,561
June						
1st period	347	58	76	134	612	1,093
2nd period	353	62	78	140	604	1,097
3rd period	390	65	99	164	646	1,200
Total	1,090	185	253	438	1,862	3,390
July						
1st period	309	50	46	96	488	893
2nd period	300	51	43	94	452	846
3rd period	334	50	30	80	461	875
Total	943	151	119	270	1,401	2,614
August						
1st period	268	38	31	69	363	700
2nd period	224	26	30	56	230	510
3rd period	202	22	30	52	110	364
Total	694	86	91	177	703	1,574
September						
1st period	160	21	12	33	159	352
2nd period	159	25	12	37	102	298
3rd period	131	24	4	28	70	229
Total	450	70	28	98	331	879

[1] Production from principal mines only, constituting more than 90 percent of the total output.

Source: Compiled by the Coal Control association (Sekitan Tosei Kai), November 1945.

APPENDIX TABLE 10.—*Production of coking and non-coking coal at principal mines in Hokkaido, fiscal years 1940–44*

[In thousands of metric tons]

Mine	Coking[1]	1940	1941	1942	1943	1944
Ubari	Yes	2,054	2,178	2,103	2,165	2,272
Bibai	No	1,678	1,610	1,595	1,597	1,398
Sunagawa	Yes	1,612	1,482	1,425	1,441	1,379
Mitsui-bibai	No	815	789	848	906	966
Horachi	Yes	625	656	738	772	775
Oyubari	Yes	736	763	691	700	738
Horonai	No	666	687	709	684	619
Ashibetsu	Yes	13	144	283	404	591
Ponbetsu	No	260	302	318	369	411
Mangi	Yes	324	348	348	355	339
Akabiro	Yes	55	50	113	239	304
Poyorato	Yes	358	328	281	238	279
Akama	Yes	94	123	141	181	275
Kamitashinai	Yes	301	333	330	303	266
Tarutori	No	633	670	586	576	251
Mayachi	Yes	169	187	195	211	226
Tubetsu	No	603	664	611	557	199
Shows	No	129	131	135	163	181
Higashihoronai	No	124	167	189	176	94
Shakubetsu	No	221	245	204	209	71
Urahora	No	186	174	170	175	64
Seppo	No	346	238	262	273	
Others		3,396	3,478	3,381	2,953	2,711
Total		15,378	15,747	15,656	15,647	14,409

[1] "Yes" indicates that a partciular mine produces some coal of coking quality; it does mean that the entire output of that mine, as represented by the data given, is coking coal.

Source: Compiled by the Japan, Manchukuo, China Coal federation (Nichi Manshi Sekitan Renmei), November 1945.

APPENDIX TABLE 11.—*Production of coking and non-coking coal at principal mines in Honshu, fiscal years 1940–44*

[In thousands of metric tons]

Mine	Coking	1940	1941	1942	1943	1944
Eastern Honshu						
Johan	No	1,379	1,130	1,253	1,213	1,111
Yoshima	No	371	372	365	422	478
Nakoso	No	288	217	220	288	242
Takahigi	No	173	180	271	289	231
Others		1,804	1,558	1,761	1,858	1,340
Total		4,015	3,457	3,870	4,070	3,432
Western Honshu						
Okinoyama	No	1,270	1,263	1,076	1,173	1,046
Higashimizume	No	1,006	912	837	751	810
Sanyomuen	Anthracite	397	314	263	283	222
Okiube	No	120	142	129	195	184
Hagimori	No	88	102	109	177	152
Motoyaoa	No	199	54	119	187	111
Others		1,781	1,749	1,575	1,760	1,438
Total		4,861	4,536	4,108	4,526	3,963

Source: Compiled by the Japan, Manchukuo, China Coal federation (Nichi Manshi Sekitan Renmei), November 1945.

APPENDIX TABLE 12.—*Production of coking and non-coking coal at principal mines in Kyushu, fiscal years 1940–44*

[In thousands of metric tons]

Mine	Coking[1]	1940	1941	1942	1943	1944
Miike	Yes	3,669	3,722	3,533	3,781	4,032
Tagawa	Yes	2,061	2,051	1,975	1,933	1,777
Onoura	Yes	1,583	1,471	1,419	1,397	1,239
Sakito	Yes	1,185	1,200	1,160	1,260	1,072
Takamatsu	No	1,544	1,087	908	1,015	925
Futase	Yes	975	1,011	896	948	879
Yamano	Yes	1,016	943	762	1,034	859
Namazuta	No	801	741	697	717	644
Akaike	No	776	621	649	659	574
Takashima	Yes	730	785	789	730	572
Kishima	No	750	775	639	662	514
Hojo	No	702	686	663	623	497
Iizuka	Yes	685	632	607	607	493
Shinnyu	No	525	528	517	501	478
Omine	No	632	585	521	519	485
Yoshio	No	487	438	414	421	401
Kamiyamada	Yes	541	524	536	527	392
Shishimachi	Yes	316	334	369	409	386
Kaho	Yes	285	321	340	401	348
Tadakuma	Yes	442	452	383	345	320
Katsuta	No	298	362	333	322	301
Nakazuru	No	631	249	335	368	289
Oshima	Yes	175	187	211	248	288
Yoshikuma	Yes	282	275	294	350	273
Tsunawake	Yes	379	345	294	320	270
Sbakanuo	Yes	461	427	403	383	268
Searyu	Yes	213	295	241	280	256
Arate	No	309	249	286	344	248
Sagara	No	241	210	209	214	233
Otsuji	No	418	381	352	323	231
Hokoku	No	407	242	284	250	219
Hirayama	Yes	277	267	282	285	218
Emukai	Yes	181	194	173	195	206
Takada	Yes	242	244	237	218	204
Matsuura	No	257	235	220	230	201
Matsuki	Yes	184	196	174	218	174
Hoshu	No	165	213	260	259	173
Eguchi	No	85	84	174	201	154
Kamiyama	No	174	158	201	209	150
Ozuru	No	139	145	172	177	139
Others		7,832	7,997	7,641	7,414	6,149
Total		33,055	31,862	30,544	31,295	27,531

[1] "Yes" indicates that a particular mine produces some coal of coking quality; it does not mean that the entire output of that mine, as represented by the data given, is coking coal.

Source: Compiled by the Japan, Manchukuo, China Coal federation (Nichi Manshi Sekitan Renmei), November 1945.

APPENDIX TABLE 13.—*Daily coal production at Miike mines during period of air attacks on Omuta, Kyushu, June–August 1945.*

[In metric tons]

Date	June	July	August
1	11,332	4,407	2,746
2	10,862	7,603	3,784
3	10,581	6,667	2,843
4	11,761	6,538	3,984
5	8,952	8,334	4,113
6	10,346	6,498	4,313
7	10,663	6,093	[3] 1,460
8	7,574	6,937	1,812
9	10,571	7,543	2,977
10	5,964	7,812	1,561
11	9,595	4,858	1,335
12	10,097	6,425	1,831
13	9,399	7,121	2,084
14	10,766	6,176	
15	6,751	6,337	1,288
16	11,018	6,175	
17	7,709	4,507	
18	[1] 928	6,936	
19	4,378	6,264	1,111
20	7,021	6,791	708
21	6,005	4,446	965
22	8,826	5,593	1,865
23	7,404	6,899	2,014
24	7,885	5,978	1,284
25	6,706	6,897	1,501
26	8,593	5,802	
27	8,449	(?)	1,437
28	5,302	533	2,151
29	7,521	3,355	2,144
30	8,571	2,696	2,185
31		3,901	2,114
Monthly total	251,527	176,122	55,607

[1] On 18 June, 785.4 tons of incendiary bombs were dropped on the Omuta area by 116 B-29s, and .217 square mile, or 4 per cent of the total built up area was damaged.
[2] On 27 July, 124 B-29s dropped 964.6 tons of incendiaries on the Omuta urban and industrial area, burning out 38 per cent of the total built up area.
[3] On 7 August, 17 B-24s dropped 68 tons of 1000-lb HE bombs, with the Miike Dyestuffs and High Pressure Works as the primary target.

Source: Compiled by the Mitsui Mining company, November 1945.

APPENDIX TABLE 14.—*Coal mining labor force, production, and output per employee per year, in Japan proper,* [1] *Great Britain,* [2] *and the United States,* [3] *1941–45.*

	1941	1942	1943	1944	1945
Employes (–000)					
Japan:					
Japanese workers	279	273	265	266	261
Koreans and others	60	102	128	150	151
Total	339	375	393	416	412
Great Britain	698	709	708	710	na
United States	457	462	416	393	na
Annual production (in *thousands of metric tons*)					
Japan	55.6	54.2	55.5	49.3	32.2
Great Britain	209.6	206.9	197.6	191.0	na
United States	466.4	528.7	535.5	562.1	na
Output per employe per year (*in metric tons*)					
Japan	164	144	141	119	78
Great Britain	300	292	279	269	na
United States	1,021	1,144	1,287	1,430	na

[1] Source: Coal Control association (Sekitan Tosei Kai), November 1945. Fiscal years. Includes all employes engaged in coal mining, as of end of fiscal year, except 1945 is as of April 30. Production figures for 1945 are conversions to annual rate of production in first six months.
[2] Source: "Statistical Digest, Ministry of Fuel and Power," London 1944. Calendar years. Employment figures represent average number of wage-earners on colliery books. Includes salable mined coal only, and omits government strip-mining operations. Production figures for 1944 are conversions to annual rate of production in first six months.
[3] Source: "Bituminous Coal in 1944, including Lignite," U. S. Bureau of Mines, 1945. Calendar years. Employment figures represent average number of men employed at active mines. Includes bituminous and lignite mining only, omitting anthracite.

na Indicates data not available.

APPENDIX TABLE 15.—*Analysis of changes in coal mining labor force, by type, monthly for fiscal years 1941–44*

Year	Added to payrolls during month					Discharged during month					Number on payrolls at end of month						Percentage added during month	Percentage discharged during month
	Japanese		Koreans	Prisoners of war	Chinese	Total	Japanese		Koreans	Prisoners of war	Chinese	Total	Japanese		Koreans	Prisoners of war	Chinese	Total		
	Full-time	Short-time					Full-time	Short-time					Full-time	Short-time						
1941																				
April	28,788	.....	5,402	.....	.....	34,190	35,262	.....	4,521	.....	.....	39,783	292,583	.....	45,651	.....	.....	338,234	10.1	11.8
May	24,832	.....	1,065	.....	.....	25,897	27,182	.....	2,110	.....	.....	29,292	290,233	.....	44,606	.....	.....	334,839	7.7	8.7
June	21,011	.....	1,773	.....	.....	22,784	22,398	.....	2,282	.....	.....	24,680	288,846	.....	44,097	.....	.....	332,943	6.8	7.4
July	26,146	6,612	1,579	.....	.....	34,337	31,264	492	2,571	.....	.....	34,327	283,728	6,120	43,105	.....	.....	332,953	10.3	10.3
August	24,703	9,065	2,139	.....	.....	35,907	25,665	3,693	2,814	.....	.....	32,172	282,766	11,492	42,430	.....	.....	336,688	10.7	9.6
September	25,407	2,286	1,784	.....	.....	29,477	25,032	10,507	2,565	.....	.....	38,104	283,141	3,271	41,649	.....	.....	328,061	9.0	11.6
October	19,930	1,182	1,637	.....	.....	22,749	22,306	2,462	2,350	.....	.....	27,118	280,765	1,991	40,936	.....	.....	323,692	7.0	8.4
November	18,333	2,238	1,734	.....	.....	22,305	16,196	1,143	2,556	.....	.....	19,895	282,902	3,086	40,114	.....	.....	326,102	6.8	6.1
December	18,833	13,030	4,276	.....	.....	36,139	14,636	3,313	2,824	.....	.....	20,773	287,099	12,803	41,566	.....	.....	341,468	10.6	6.1
1942																				
January	19,705	11,650	3,619	.....	.....	34,974	16,444	3,180	2,101	.....	.....	21,725	290,360	21,273	43,084	.....	.....	354,717	9.9	6.1
February	14,430	4,956	3,992	.....	.....	23,378	16,164	8,249	2,201	.....	.....	26,614	288,626	17,980	44,875	.....	.....	351,481	6.7	7.6
March	16,920	2,426	4,973	.....	.....	24,319	21,371	11,923	3,390	.....	.....	36,684	284,175	8,483	46,458	.....	.....	339,116	7.2	10.8
April	17,969	839	3,556	.....	.....	22,364	13,966	7,620	3,446	.....	.....	24,132	289,078	1,702	46,508	.....	.....	337,348	6.6	7.2
May	14,094	2,221	5,861	.....	.....	22,176	15,150	1,134	3,476	.....	.....	19,760	288,022	2,789	48,353	.....	.....	339,764	6.5	5.8
June	10,494	3,926	6,125	.....	.....	20,545	12,624	2,387	4,010	.....	.....	19,021	285,892	4,328	51,068	.....	.....	341,288	6.0	5.6
July	13,375	4,737	9,787	.....	.....	27,899	11,655	2,522	4,818	.....	.....	18,995	287,612	6,543	56,037	.....	.....	350,192	8.0	5.4
August	11,743	10,035	3,890	.....	.....	25,668	12,088	4,157	2,931	.....	.....	19,176	287,267	12,421	56,996	.....	.....	356,684	7.2	5.4
September	13,343	3,739	6,628	.....	.....	23,710	15,928	10,345	5,827	.....	.....	32,100	284,682	5,815	57,797	.....	.....	348,294	6.8	9.2
October	11,920	1,600	11,994	.....	.....	25,514	15,088	4,996	5,848	.....	.....	25,932	281,514	3,419	63,943	.....	.....	347,876	7.3	7.5
November	11,014	5,799	11,149	.....	.....	27,962	11,939	2,243	5,755	.....	.....	19,937	280,589	5,975	69,337	.....	.....	355,901	7.9	5.6
December	14,650	8,293	10,957	.....	.....	33,810	14,120	5,772	4,851	.....	.....	24,743	281,119	8,406	75,443	.....	.....	364,968	9.3	6.8
1943																				
January	12,894	21,749	5,410	.....	.....	40,053	19,372	3,161	1,923	.....	.....	24,456	274,641	26,994	78,930	.....	.....	380,565	10.5	6.4
February	14,441	6,221	6,203	.....	.....	26,865	13,577	6,205	4,564	.....	.....	24,346	275,505	27,010	80,569	.....	.....	383,084	7.0	6.4
March	16,752	5,535	7,270	.....	.....	29,557	15,637	19,481	2,758	.....	.....	37,876	276,618	13,064	85,081	.....	.....	374,763	7.9	10.1
April	13,355	7,627	4,967	1,233	.....	27,182	15,488	9,786	4,352	.....	.....	29,626	274,485	10,905	85,696	1,233	.....	372,319	7.3	8.0
May	11,864	3,972	8,365	599	.....	24,800	17,177	4,968	5,456	6	.....	27,607	269,172	9,909	88,605	1,826	.....	369,512	6.7	7.5
June	12,764	7,795	5,160	187	.....	25,906	13,894	8,309	3,596	7	.....	25,806	268,042	9,395	90,169	2,006	.....	369,612	7.0	7.0
July	9,323	5,627	4,510	54	267	19,781	11,073	3,963	5,460	2	.....	20,498	249,320	11,059	106,191	2,058	267	368,895	5.4	5.6
August	11,451	9,739	8,646	499	.....	30,335	11,231	8,444	5,616	2	.....	25,293	249,540	12,354	109,221	2,555	267	373,937	8.1	6.8
September	9,520	5,813	8,234	.....	.....	23,567	11,905	5,804	6,260	1	.....	23,970	247,155	12,363	111,195	2,554	267	373,534	6.3	6.4
October	9,589	8,544	6,008	251	.....	24,392	11,876	10,011	6,178	.....	2	28,067	244,868	10,896	111,025	2,805	265	369,859	6.6	7.6
November	8,895	5,846	7,089	.....	285	22,115	10,302	4,239	4,720	.....	.....	19,261	243,461	12,503	113,394	2,805	550	372,713	5.9	5.2
December	9,350	14,096	8,674	555	.....	32,678	11,281	11,070	3,728	5	2	26,086	241,530	15,529	118,340	3,358	548	379,305	8.6	6.9
1944																				
January	10,325	19,519	5,608	.....	.....	35,452	8,679	4,190	4,072	77	.....	17,018	243,176	30,858	119,876	3,281	548	397,739	8.9	4.3
February	9,052	11,242	7,186	.....	.....	27,480	9,410	11,321	3,610	.....	.....	24,341	242,818	30,779	123,452	3,281	548	400,878	6.9	6.1
March	11,777	11,676	4,885	5	.....	28,343	12,735	19,884	4,206	7	7	36,839	241,860	22,571	124,131	3,279	541	392,382	7.2	9.4
April	12,899	10,279	6,208	29	.....	29,415	11,003	11,688	5,313	9	3	28,016	243,033	21,039	125,232	3,299	538	394,034	7.5	7.1
May	8,312	6,373	4,817	262	643	20,347	11,739	14,453	6,290	17	1	32,500	240,508	12,950	125,759	3,484	1,180	381,881	5.3	8.5
June	8,217	7,341	8,628	847	204	25,237	12,412	6,893	6,852	4	.....	26,161	236,313	13,398	125,535	4,327	1,384	380,957	6.6	6.9
July	9,349	16,094	6,282	475	889	33,089	12,902	9,075	8,430	198	23	27,628	232,760	23,417	123,387	4,604	2,250	386,418	8.6	7.1
August	8,216	18,166	9,740	705	721	37,548	9,289	7,595	11,402	55	12	28,353	231,687	33,988	121,725	5,254	2,959	395,613	9.5	7.2
September	10,570	6,676	14,021	930	768	32,965	11,509	7,860	7,598	53	24	27,044	230,748	32,804	128,148	6,131	3,703	401,534	8.2	6.7
October	14,678	6,169	15,189	153	1,414	37,603	9,127	12,874	8,860	2	115	30,978	236,299	26,099	134,477	6,282	5,002	408,159	9.2	7.6
November	16,355	6,274	5,760	.....	2,210	30,599	9,816	6,715	9,463	5	75	26,074	242,838	25,658	130,774	6,277	7,137	412,684	7.4	6.3
December	14,171	7,913	6,280	32	447	28,843	10,075	5,521	6,266	285	93	22,340	246,934	27,950	130,788	6,024	7,491	419,187	6.9	5.3
1945																				
January	7,280	12,767	9,045	429	370	29,891	9,643	12,670	6,318	30	111	28,772	244,571	28,047	133,515	6,423	7,750	420,306	7.1	6.8
February	7,703	7,731	10,072	220	.....	25,726	7,096	5,995	6,762	89	95	20,037	245,178	29,783	136,825	6,554	7,655	425,995	6.0	4.7
March	6,868	4,449	6,922	61	491	18,791	8,275	12,227	7,996	65	96	28,659	243,771	22,005	135,751	6,550	8,050	416,127	4.5	6.9
April	12,791	5,798	7,251	927	1,639	28,406	11,508	11,721	8,910	115	128	32,382	245,054	16,082	134,092	7,362	9,651	412,241	6.9	7.9

Source: Coal Control association (Sekitan Tosei Kai), October 1945.

APPENDIX TABLE 16.—*Average coal production per employe per year in Japan proper, by districts and selected major mines, fiscal years 1930–44* [1]

[In metric tons]

	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944
Japan proper, average	153	181	203	227	213	216	211	203	193	179	173	164	154	147	119
Hokkaido, average	249	294	335	379	352	372	366	353	313	265	251	233	207	190	164
Mines:															
Yubari [2]	na	308	372	372	396	395	412	430	375	266	262	243	219	193	162
Sunagawa	463	459	353	395	445	429	253	270	288	264	238	219	201	193	163
Mitsu-bibai	320	333	379	373	405	384	331	343	293	230	233	240	244	236	211
Mitsubishi-bibai	319	304	394	496	428	421	399	365	314	326	247	265	237	223	179
Oyubari	331	296	375	443	408	450	467	352	327	323	253	248	196	202	179
Joban, average	166	193	192	210	187	171	168	162	137	130	125	121	124	121	91
Kyushu and Yamaguchi, average	137	161	183	204	194	196	190	182	165	162	157	148	141	137	113
Mines:															
Miike	348	294	260	268	258	248	204	205	192	186	181	174	169	183	157
Tagawa	203	253	243	251	260	230	195	201	191	197	192	201	170	154	118
Yamano	240	215	228	205	219	217	194	186	174	168	168	184	154	145	90
Hojo	132	174	227	257	276	294	275	261	242	239	208	212	177	153	112
Sakito	143	173	248	318	325	346	325	286	239	206	206	212	178	198	141
Takashima	163	199	221	244	242	230	236	221	204	192	182	178	167	154	105

na Indicates data not available.

[1] Calculated from employes on rolls as of June 30 each year, except as noted in [2].

[2] Based on number of employes as of end of fiscal year.

Source: Compiled from data submitted by Coal Control association (Sekitan Tosei Kai), November 1945, except data for Yubari mine supplied by Hokkaido colliery and Steamship company November 1945.

APPENDIX TABLE 17.—*Coal mining materials required, allotted, and acquired by all coal mines in Japan proper, fiscal years 1941–45* [1].

Material	1941	1942	1943	1944	April–September 1945 (Estimated)
Rolled steel (in thousands of metric tons)					
Required	185	150	169	159	50
Allotted	163	94	164	92	6
Acquired	111	66	63	33	15
Cement (in thousands of metric tons)					
Required	120	120	110	100	50
Allotted	...	100	85	55	5
Acquired	102	90	68	36	3
Timber and lumber (in millions of cubic feet)					
Required	133	124	130	123	67
Allotted	...	104	124	107	52
Acquired	125	104	118	109	54
Explosives (in thousands of metric tons)					
Required	12	13	13	12	6
Allotted	12	12	13	11	4
Acquired	12	12	12	11	3
Raw rubber (in metric tons)					
Required	805	800	850	800	400
Allotted	...	445	450	305	146
Acquired	803	402	365	256	85

[1] "Required" is company demands after adjustment by Coal Control association in line with "estimated national supplies of materials."
"Alotted" is amount assigned under Mobilization bureau's periodic plans.
"Acquired" is amount actually received by mines.

Source: Compiled by the Coal Control association (Sekitan Tosei Kai), October 1945.

APPENDIX TABLE 18.—*Average price to consumers of Japan proper coal of average calorific value (6,000 calories), October 1940–September 1945.*

[In yen per metric ton]

Period	F.O.B. at shipping ports in Hokkaido and Kyushu	C. i. f. at ports	
		Kanto area	Kinki area
October 1940–March 1941	17.87	23.42	23.04
April 1941–September 1941	18.38	24.10	23.74
October 1941–March 1942	18.61	24.42	23.82
April 1942–March 1944	18.71	24.50	24.17
April 1944–September 1945	18.76	24.55	24.22

Source: Compiled by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 19.—*Total subsidy paid to coal producers in Japan proper, by districts, fiscal years 1941–44*

[In thousands of yen]

Period	Hokkaido	Eastern Honshu	Western Honshu	Kyushu	Total
1941					
First half	14,987	2,591	1,222	29,394	48,194
Second half	15,996	4,703	3,195	34,144	58,038
1942					
First half	15,091	7,383	6,430	41,320	70,224
Second half	26,054	13,727	9,379	62,431	111,591
1943					
First half	34,232	17,676	22,457	85,662	160,027
Second half	39,887	21,951	24,821	122,714	209,373
1944					
First half	57,499	26,293	27,681	221,981	333,454
Second half	135,442	21,218	21,946	227,199	405,805

Source: Compiled by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 20.—*Average subsidy per ton of coal paid to coal producers in Japan proper, by districts, fiscal years 1941–44.*

[In yen]

Period	Hokkaido	Eastern Honshu	Western Honshu	Kyushu	All Japan proper
1941					
First half	1.93	1.68	0.57	1.88	1.7
Second half	2.00	2.45	1.34	2.11	2.0
1942					
First half	2.05	4.17	3.50	2.97	2.8
Second half	3.15	6.54	4.13	3.75	3.8
1943					
First half	4.51	9.36	10.98	5.82	6.1
Second half	4.95	10.06	10.00	7.41	7.1
1944					
First half	7.55	14.88	13.43	16.09	13.2
Second half	19.92	12.74	11.54	16.54	16.8

Source: Compiled from data submitted by the Japan Coal company (Nihon Sekita Kaisha), November 1945.

APPENDIX TABLE 21.—*Average subsidy per million calories o coal paid to producers in Japan proper, by districts, fisca years 1941–44.*

[In yen]

Period	Hokkaido	Eastern Honshu	Western Honshu	Kyushu	All Japan proper
1941					
First half	.30	.36	.13	.31	.3
Second half	.31	.52	.31	.34	.3
1942					
First half	.32	.89	.80	.48	.4
Second half	.48	1.40	.95	.61	.6
1943					
First half	.69	2.00	2.51	.95	1.0
Second half	.76	2.15	2.29	1.20	1.1
1944					
First half	1.16	3.18	3.07	2.62	2.4
Second half	3.06	2.76	2.64	2.69	2.8

Source: Compiled from data supplied by the Japan Coal company (Nihon Sekita Kaisha), November 1945.

APPENDIX TABLE 22.—*Transfer of coal mining labor an materials from Karafuto to Japan proper, August 1944 September 1945.*

	Miners	Staff	Loading coolies	Total
Labor				
To Kyushu	5,181	127	...	5,30
To Joban	2,173	220	487	2,88
To Hokkaido	...	...	1,471	1,47
Total	7,354	347	1,958	9,65

	Shipped	Sunk en route	Arrived
Materials (in metric tons)			
To Kyushu	3,608	[1] 2,000	1,60
To Joban	250	...	25
To Hokkaido	1,000	...	1,00
Total	4,858	2,000	2,85

[1] Aboard Nannio Maru sunk at Wakamatsu.

Source: Compiled from data submitted by the Fuel bureau, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 23.—*Exports of coal from Japan proper, by destination, fiscal years 1940–45*

[In thousands of metric tons]

Year	Korea	Manchukuo	Central China	Other[1]	Total
1940	926	90	----------	475	1,491
1941	1,096	337	59	247	1,739
1942	1,014	----------	----------	582	1,596
1943	805	----------	----------	295	1,100
1944	714	----------	----------	----------	714
1945					
I	62	----------	----------	----------	62

[1] "Other" includes Formosa, South China and the Philippine Islands.

Source: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai) and the Japan, Manchukuo, China Coal federation (Nichi Manshi Sekitan Remmei), November 1945.

APPENDIX TABLE 24.—*Arrival of coal at ports of Tokyo, Yokohama and Kawasaki, August 1942–July 1945*

Year	Tokyo	Yokohama and Kawasaki	Total
1942:			
August	187,837	352,750	540,587
September	157,124	353,657	510,781
October	214,084	345,512	559,596
November	191,318	365,799	557,117
December	161,342	276,335	437,677
Total	911,705	1,694,053	2,605,758
1943:			
January	109,109	202,238	311,347
February	128,639	334,469	463,108
March	136,687	223,721	360,408
April	108,238	262,796	371,034
May	85,727	262,366	348,093
June	58,226	124,812	183,038
July	14,745	169,535	184,280
August	39,966	103,003	142,969
September	46,161	110,177	156,338
October	45,880	189,401	235,281
November	50,430	153,017	203,447
December	25,180	170,586	195,766
Total	848,988	2,306,121	3,155,109
1944:			
January	28,695	153,503	182,198
February	30,696	161,049	191,745
March	14,260	103,746	118,006
April	----------	75,893	75,893
May	2,260	62,454	64,714
June	5,850	71,555	77,405
July	----------	24,813	24,813
August	4,890	38,257	43,147
September	1,480	17,450	18,930
October	1,327	29,756	31,083
November	2,690	32,108	34,798
December	----------	3,490	3,490
Total	92,148	774,074	866,222
1945:			
January	635	62,796	63,431
February	635	42,599	43,234
March	----------	20,840	20,840
April	----------	----------	----------
May	----------	10,500	10,500
June	----------	----------	----------
July	----------	----------	----------
Total	1,270	136,735	138,005

Source: Data prepared by Takabashi, T., former Chief of the Mitsui Coal depot, Kawasaki, November 1945.

APPENDIX TABLE 25.—*Coal supply position in the districts of Japan proper, fiscal years 1940–45*

[In thousands of metric tons]

District	Year	Produced	Exported	Shipped to other districts	Amount of local production remaining for local use	Imported	Shipped from other districts	Available supply
Hokkaido	1940	15,378	280	8,543	6,555	345	----------	6,900
	1941	15,747	305	7,329	8,113	471	----------	8,584
	1942	15,656	313	8,188	7,155	479	----------	7,634
	1943	15,647	210	6,794	8,643	87	----------	8,730
	1944:							
	I	3,907	----------	1,516	2,391	----------	----------	2,391
	II	3,704	----------	1,364	2,340	----------	----------	2,340
	III	3,558	----------	1,622	1,936	----------	----------	1,936
	IV	3,240	6	1,415	1,819	----------	----------	1,819
	Total	14,409	6	5,917	8,486	----------	----------	8,486
	1945:							
	I	3,268	11	1,568	1,689	----------	----------	1,689
Honshu	1940	8,876	80	61	8,735	7,659	24,779	41,173
	1941	7,993	90	28	7,875	7,198	21,152	36,225
	1942	7,978	2	7	7,969	6,563	22,104	36,636
	1943	8,396	----------	37	8,559	4,616	21,332	34,507
	1944:							
	I	1,973	----------	----------	1,973	1,047	4,892	7,912
	II	1,855	----------	----------	1,855	845	4,284	6,984
	III	1,752	----------	----------	1,752	418	4,781	6,951
	IV	1,815	----------	----------	1,815	203	4,133	6,151
	Total	7,395	----------	----------	7,395	2,513	18,090	27,998
	1945:							
	I	1,542	----------	----------	1,542	157	3,662	5,361
Eastern Honshu	1943	4,070	----------	----------	4,070	2,830	9,606	16,506
	1944:							
	I	893	----------	----------	893	700	2,291	3,884
	II	874	----------	----------	874	579	1,901	3,354
	III	764	----------	----------	764	210	2,237	3,211
	IV	901	----------	----------	901	102	2,108	2,111
	Total	3,432	----------	----------	3,432	1,591	8,537	13,560
	1945:							
	I	689	----------	----------	689	100	1,948	2,737
Western Honshu	1943	4,526	----------	417	4,109	1,786	12,106	18,001
	1944:							
	I	1,080	----------	58	1,022	347	2,659	4,028
	II	981	----------	31	950	266	2,414	3,630
	III	988	----------	31	957	208	2,575	3,740
	IV	914	----------	28	886	101	2,053	3,040
	Total	3,963	----------	148	3,815	922	9,701	14,438
	1945:							
	I	853	----------	25	828	57	1,739	2,624
Kyushu	1940	33,055	1,131	16,236	15,688	2,119	61	17,868
	1941	31,862	1,344	13,823	16,695	1,916	28	18,639
	1942	30,544	1,281	13,916	15,347	1,706	7	17,060
	1943	31,295	890	14,538	15,867	1,326	37	17,230
	1944:							
	I	7,344	284	3,376	3,684	203	----------	3,887
	II	6,452	98	2,920	3,434	164	----------	3,598
	III	7,054	116	3,161	3,777	152	2	3,931
	IV	6,681	210	2,718	3,753	103	----------	3,856
	Total	27,531	708	12,175	14,648	622	2	15,272
	1945:							
	I	6,067	51	2,094	3,922	31	----------	3,953

Sources: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai) and the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 26.—*Inter-island movement of coal to Honshu, by source and type of transportation, fiscal years 1941–45*

[In thousands of metric tons]

Year	From Hokkaido			From Kyushu			Grand total		
	Water	Rail	Total	Water	Rail	Total	Water	Rail	Total
1941	7,316	13	7,329	13,379	444	13,823	20,695	457	21,152
1942	8,071	117	8,188	12,056	1,860	13,916	20,127	1,977	22,104
1943:									
I	1,569	117	1,686	2,811	866	3,677	4,380	983	5,363
II	1,142	120	1,262	2,565	913	3,478	3,707	1,033	4,740
III	1,595	129	1,724	2,394	1,268	3,662	3,989	1,397	5,386
IV	1,886	236	2,122	2,366	1,355	3,721	4,252	1,591	5,843
Total	6,192	602	6,794	10,136	4,402	14,538	16,328	5,004	21,332
1944:									
April	668	77	745	762	446	1,208	1,430	523	1,953
May	348	125	473	624	489	1,113	972	614	1,586
June	180	118	298	568	487	1,055	748	605	1,353
July	193	124	317	557	460	1,017	750	584	1,334
August	410	157	567	513	427	940	923	584	1,507
September	340	140	480	504	459	963	844	599	1,443
October	378	135	513	567	427	994	945	562	1,507
November	449	141	590	647	461	1,108	1,096	602	1,698
December	407	110	517	572	487	1,059	979	597	1,576
January	336	83	419	414	488	902	750	571	1,321
February	326	86	412	463	459	922	789	545	1,334
March	446	138	584	447	447	894	893	585	1,478
Total	4,881	1,434	5,915	6,638	5,537	12,175	11,119	6,971	18,090
1945:									
April	458	118	576	367	416	783	825	534	1,359
May	460	135	595	260	467	727	720	602	1,322
June	259	138	397	191	393	584	450	531	981
July	275	75	350	189	311	500	464	386	850
August	240		240	86	120	206	326	120	446
Total	1,692	466	2,158	1,093	1,707	2,800	2,785	2,173	4,958

Sources: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai), and the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 27.—*Inter-island movement of coal to Honshu, by type of transportation, fiscal years 1941–45*

[In thousands of metric tons]

Year	By water			By railway	Grand total
	Steamship	Other vessels	Total		
1941	10,537	10,158	20,695	457	21,152
1942	9,912	10,215	20,127	1,977	22,104
1943:					
I	1,941	2,439	4,380	983	5,363
II	1,374	2,333	3,707	1,033	4,740
III	1,714	2,275	3,989	1,397	5,386
IV	2,012	2,240	4,252	1,591	5,843
Total	7,041	9,287	16,328	5,004	21,332
1944:					
April	645	785	1,430	523	1,953
May	390	582	972	614	1,586
June	191	557	748	605	1,353
July	183	567	750	584	1,334
August	406	517	923	584	1,507
September	382	462	844	599	1,443
October	436	509	945	562	1,507
November	597	499	1,096	602	1,698
December	597	382	979	597	1,576
January	446	304	750	571	1,321
February	456	333	789	545	1,334
March	458	435	893	585	1,478
Total	5,187	5,932	11,119	6,971	18,090
1945:					
April	459	366	825	534	1,359
May	427	293	720	602	1,322
June	217	233	450	531	981
July	239	225	464	386	850
August	199	127	326	120	446
Total	1,541	1,244	2,785	2,173	4,958

Sources: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai), and the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 28.—*Movement of coal from Hokkaido to Honshu, by type of transportation, fiscal years 1941–45*

[In thousands of metric tons]

Year	By water			By railway	Grand total
	Steamship	Other vessels	Total		
1941	7,192	124	7,316	13	7,329
1942	7,741	330	8,071	117	8,188
1943:					
I	1,480	89	1,569	117	1,686
II	1,023	119	1,142	120	1,262
III	1,474	121	1,595	129	1,724
IV	1,652	234	1,886	236	2,122
Total	5,629	563	6,192	602	6,794
1944:					
April	526	142	668	77	745
May	218	130	348	125	473
June	49	131	180	118	298
July	44	149	193	124	317
August	274	136	410	157	567
September	250	90	340	140	480
October	264	114	378	135	513
November	338	111	449	141	590
December	339	68	407	110	517
January	269	67	336	83	419
February	273	53	326	86	412
March	313	133	446	138	584
Total	3,157	1,324	4,481	1,434	5,915
1945:					
April	326	132	458	118	576
May	335	125	460	135	595
June	165	94	259	138	397
July	189	86	275	75	350
August	185	55	240		240
Total	1,200	492	1,692	466	2,158

Sources: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai), and the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 29.—*Movement of coal from Kyushu to Honshu, by type of transportation, fiscal years 1941–45*

[In thousands of metric tons]

Year	By water			By railway	Grand total
	Steamships	Other vessels	Total		
1941	3,345	10,034	13,379	444	13,823
1942	2,171	9,885	12,056	1,860	13,916
1943:					
I	461	2,350	2,811	866	3,677
II	351	2,214	2,565	913	3,478
III	240	2,154	2,394	1,268	3,662
IV	360	2,006	2,366	1,355	3,721
Total	1,412	8,724	10,136	4,402	14,538
1944:					
April	119	643	762	446	1,208
May	172	452	624	489	1,113
June	142	426	568	487	1,055
July	139	418	557	460	1,017
August	132	381	513	427	940
September	132	372	504	459	963
October	172	395	567	427	994
November	259	388	647	461	1,108
December	258	314	572	487	1,059
January	177	237	414	488	902
February	183	280	463	459	922
March	145	302	447	447	894
Total	2,030	4,608	6,638	5,537	12,175
1945:					
April	133	234	367	416	783
May	92	168	260	467	727
June	52	139	191	393	584
July	50	139	189	311	500
August	14	72	86	120	206
Total	341	752	1,093	1,707	2,800

Sources: Compiled from data submitted by the Coal Control association (Sekitan Tosei Kai), and the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 30.—*Coal imports into Japan proper, by source, fiscal years 1939–45*

[In thousands of metric tons]

Year	Karafutn	Korea	Manchukuo	Formosa	North China-Inner Mongolia	Indo-China, etc.	Total
1939	2,542	1,011	848	255	3,042	587	8,285
1940	3,328	1,467	773	263	3,800	492	10,123
1941	3,310	1,078	687	39	4,120	351	9,585
1942	2,198	910	642	175	4,539	284	8,748
1943							
1/2	1,414	319	293	5	1,967	75	4,073
2/2	236	177	121	.....	1,422	.....	1,956
Total	1,650	496	414	5	3,389	75	6,029
1944:							
April	.....	28	50	.....	185	.....	263
May	104	41	69	.....	185	.....	399
June	314	27	54	.....	193	.....	588
July	348	30	45	.....	174	.....	597
August	35	14	37	.....	128	.....	214
September	6	16	53	.....	123	.....	198
October	.....	15	56	.....	156	.....	227
November	.....	26	39	.....	127	.....	192
December	.....	10	49	.....	92	.....	151
Jaquary	.....	12	55	.....	84	.....	151
February	.....	18	41	.....	34	.....	93
March	.....	15	13	.....	34	.....	62
Total	807	252	561	.....	1,515	.....	3,135
1945:							
April	.....	15	12	.....	53	.....	80
May	.....	12	16	.....	35	.....	63
June	.....	5	8	.....	32	.....	45
Total	.....	32	36	.....	120	.....	188

Source: Compiled by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 31.—*Coal stocks awaiting transportation in Japan proper, by districts, March 1944-October 1945*

[In thousands of metric tons]

	Hokkaido				Joban	Ube			Kyushu			Total			
	At mine	At port	In dumps[1]	Total	At mine	At mine	At port	Total	At mine	At port	Total	At mine	At port	In dumps[1]	Total
1944:															
March	773	682	494	1,949	90	209	9	218	799	760	1,559	1,871	1,451	494	3,81
April	698	625	489	1,812	92	172	66	238	745	714	1,459	1,707	1,405	489	3,60
May	682	809	480	1,971	75	171	66	237	726	712	1,438	1,654	1,587	480	3,72
June	710	955	458	2,123	59	195	50	245	682	581	1,263	1,646	1,586	458	3,69
July	718	1,110	436	2,264	51	201	60	261	773	446	1,219	1,743	1,616	436	3,79
August	737	1,001	408	2,146	65	219	46	265	826	466	1,292	1,847	1,513	408	3,76
September	807	984	383	2,174	51	225	41	266	823	596	1,419	1,906	1,621	383	3,91
October	815	936	357	2,108	45	238	31	269	834	687	1,521	1,932	1,654	357	3,94
November	808	858	328	2,004	48	245	35	280	873	593	1,466	1,974	1,486	338	3,79
December	1,044	796	326	2,166	67	145	61	206	1,043	623	1,666	2,299	1,480	326	4,10
1945:															
January	1,198	687	321	2,206	78	162	46	208	1,083	575	1,658	2,521	1,308	321	4,15
February	1,278	602	317	2,197	101	154	34	188	1,089	517	1,606	2,622	1,153	317	4,09
March	1,235	551	304	2,090	123	151	33	184	1,105	529	1,634	2,614	1,113	304	4,03
April	1,139	447	284	1,870	116	149	31	180	1,094	552	1,646	2,498	1,030	284	3,81
May	1,067	425	258	1,750	114	138	46	184	1,108	654	1,762	2,427	1,125	258	3,81
June	1,006	520	221	1,747	137	156	33	189	1,201	762	1,963	2,500	1,315	221	4,03
July	946	579	213	1,738	100	185	29	214	1,183	878	2,061	2,414	1,486	213	4,11
August	881	442	194	1,517	95	215	34	249	1,202	1,032	2,234	2,393	1,508	194	4,09
September	791	312	167	1,270	78	215	25	240	1,120	1,023	2,143	2,204	1,360	167	3,73
October	725	167	154	1,046	75	203	16	219	970	877	1,847	1,973	1,060	154	3,18

[1] Stored in dumps along railways.

Notes: If mine is located at a port, stocks are included in "port" columns. "At Mine" figures are based on reports submitted by mines every 10 days; "At Port" figures reporte by Branch Offices of the Japan Coal company every 10 days.
Amount of coal stocked by consumers is unknown, but is estimated by the Japan Coal company to have approximated 1,500,000 to 2,000,000 tons under normal conditions, a to have nearly disappeared by August 1945.

Source: Compiled by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 32.—*Loadings of coal and coke by the Japanese Government railways, fiscal years 1936–45*

[In thousands of metric tons]

Years	Coal	Coke
1936	31,460	351
1937	33,370	424
1938	36,219	633
1939	39,346	817
1940	41,994	1,147
1941	38,670	1,319
1942:		
I	9,449	422
II	8,848	487
III	9,985	474
IV	10,282	418
Total	38,564	1,801
1943		
I	12,376	488
II	11,425	543
III	12,043	450
IV	12,954	445
Total	48,798	1,926
1944:		
April	4,282	151
May	4,340	171
June	3,877	172
July	3,813	169
August	3,649	167
September	3,578	175
October	3,561	151
November	3,706	165
December	3,617	139
January	3,288	126
February	3,104	121
March	3,802	150
Total	44,617	1,857
1945:		
April	3,535	161
May	3,612	194
June	3,275	158
Total	10,422	513

Source: Compiled by the Japanese Government railways, November 1945.

APPENDIX TABLE 33.—*Consumption of coal in Japan proper, by industries, excluding consumption by coal mines, fiscal years 1933–45*

[In thousands of metric tons]

Industry	1933	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 (Apr.–July)
Iron and steel:												
For coke	3,089	4,130	4,339	4,941	5,573	6,718	7,997	8,972	8,424	7,938	6,190	1,255
For fuel	975	1,129	1,790	1,698	2,413	3,339	3,442	4,199	4,891	5,764	5,051	1,165
Total	4,064	5,259	6,129	6,639	7,986	10,057	11,439	13,171	13,315	13,702	11,241	2,420
Shipbuilding	104	120	128	164	167	166	190	193	230	284	446	148
Machinery manufacture	345	408	570	699	1,111	1,514	1,780	1,931	1,966	2,178	2,179	472
Metal mining and refining	197	517	606	725	881	664	857	952	778	714	603	157
Gas and coke	1,881	2,214	2,342	2,564	3,219	3,685	3,945	4,080	3,946	3,804	3,558	506
Electric power	1,881	2,876	3,206	3,747	4,329	6,200	5,898	4,202	5,261	5,077	3,705	588
Chemical industry	2,673	2,506	3,295	3,958	4,770	6,417	7,150	6,572	5,803	6,158	4,715	1,057
Ceramics, including cement	2,871	3,686	3,949	4,287	4,261	4,114	4,665	3,779	3,457	2,929	2,029	507
Fibre and textiles	3,274	5,449	6,384	6,968	6,919	6,420	6,724	4,926	3,080	2,109	1,026	260
Foodstuffs	2,098	1,370	1,528	1,428	1,437	1,541	1,503	1,527	1,218	958	684	187
Salt	776	753	731	702	579	718	625	355	374	362	331	83
Railroads	3,408	3,722	4,008	4,126	4,442	5,076	5,568	5,105	6,300	6,960	8,086	2,716
Liquid fuel						64	387	603	1,012	1,234	1,573	543
Briquets		1,288	1,367	1,430	1,527	1,666	2,206	1,780	1,358	1,035	439	88
Non-industrial heating and cooking		3,781	4,043	4,075	3,648	3,103	3,225	3,361	2,416	2,152	2,026	564
Government factories and miscellaneous	3,859	514	523	408	374	1,090	1,366	1,327	2,005	1,482	1,135	377
Army									1,931	1,731	1,368	430
Navy		726	659	887	1,279	1,879	2,290	3,325	1,830	1,833	1,480	360
Ship bunkering	4,035	4,498	4,487	4,701	4,454	3,722	3,804	2,951	2,517	2,010	1,047	241
Total	31,466	39,687	43,955	47,508	51,383	58,096	63,622	60,140	58,797	56,709	47,471	11,704

Source: Compiled by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 34.—*Consumption of coal in Japan proper, by industries, excluding consumption by coal mines, in percentages of total consumption, fiscal years 1933–45*

Industry	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942		1943		1944		1945
										1/2	2/2	1/2	2/2	1/2	2/2	1/2
Iron and steel:																
For coke	9.8	10.8	10.4	9.8	10.4	10.8	11.6	12.6	14.9	15.0	13.8	14.9	13.2	14.0	11.8	9.8
For fuel	3.1	3.3	2.8	4.1	3.6	4.7	5.7	5.4	7.0	8.9	7.8	11.0	9.4	10.6	10.7	9.2
Total	12.9	14.1	13.2	13.9	14.0	15.5	17.3	18.0	21.9	23.9	21.6	25.9	22.6	24.6	22.5	19.0
Shipbuilding	.3	.3	.3	.3	.4	.3	.3	.3	.3	.4	.4	.5	.5	.7	1.2	1.2
Machinery manufacture	1.1	1.1	1.0	1.3	1.5	2.2	2.6	2.8	3.2	3.5	3.2	3.5	4.1	4.5	4.7	3.7
Metal mining and refining	.6	1.0	1.3	1.4	1.5	1.7	1.1	1.3	1.6	1.3	1.3	1.4	1.2	1.3	1.2	1.4
Gas and coke	6.0	5.4	5.6	5.3	5.4	6.3	6.3	6.2	6.8	7.2	6.3	6.9	6.5	7.5	6.6	5.1
Electric power	6.0	7.3	7.2	7.3	7.9	8.4	10.6	9.3	7.0	7.9	10.0	9.5	8.4	7.5	8.1	4.4
Chemical industry	8.5	9.8	6.3	7.5	8.3	9.3	11.0	11.2	10.9	9.8	10.0	11.0	10.7	10.5	9.3	8.3
Ceramics, including cement	9.1	8.7	9.3	9.0	9.0	8.3	7.6	7.3	6.3	6.4	5.4	4.9	5.4	4.4	4.1	4.1
Fibre and textiles	10.4	10.2	13.7	14.5	14.5	13.5	11.0	10.6	8.2	6.6	4.0	3.8	3.7	2.4	1.9	2.4
Foodstuffs	6.7	6.1	3.5	3.5	3.0	2.8	2.6	2.4	2.5	2.2	2.0	1.4	2.0	1.5	1.4	1.8
Salt	2.5	2.3	1.9	1.7	1.5	1.1	1.2	1.0	.6	.9	.4	.7	.6	.7	.6	1.2
Railroads	10.8	10.2	9.4	9.1	8.7	8.6	8.7	8.8	8.5	10.8	10.6	11.2	13.3	15.2	19.1	23.5
Liquid fuel							.1	.7	1.0	1.5	1.9	2.0	2.3	2.8	3.9	4.2
Briquets			3.3	3.1	3.0	3.0	2.9	3.5	3.0	2.1	2.4	1.9	1.7	.9	.9	.7
Non-industrial heating and cooking			9.5	9.2	8.6	7.1	5.3	5.1	5.6	3.0	5.1	2.3	5.1	4.6	3.8	7.7
Government factories and miscellaneous	12.3	11.3	1.3	1.2	.9	.7	1.8	2.1	2.2	2.2	4.4	2.0	3.2	2.1	2.8	3.6
Army										3.0	3.5	3.6	2.6	3.0	2.7	3.2
Navy			1.8	1.5	1.9	2.5	3.2	3.6	5.5	2.9	3.3	3.6	2.9	3.3	2.9	2.6
Ship bunkering	12.8	12.2	11.4	10.2	9.9	8.7	6.4	5.8	4.9	4.4	4.2	3.9	3.2	2.5	2.3	1.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Compiled from data submitted by the Japan Coal company (Nihon Sekitan Kaisha), November 1945. Based on consumption reports submitted periodically by consumers.

APPENDIX TABLE 35.—*Consumption of coal in Japan proper, by industries, excluding consumption by coal mines, monthly, April 1944-September 1945*

[In thousands of metric tons]

Industry	1944													1945						
	April	May	June	July	August	September	October	November	December	January	February	March	Total	April	May	June	July	Aug	Sept	Total
Iron and steel:																				
For coke	650	657	616	628	574	474	501	458	432	393	351	456	6,190	344	374	320	217	103	62	1,420
For fuel	484	508	516	421	418	367	375	443	442	361	340	376	5,051	360	320	267	218	119	61	1,345
Total	1,134	1,165	1,132	1,049	992	841	876	901	874	754	691	832	11,241	704	694	587	435	222	123	2,765
Shipbuilding	28	33	34	29	28	26	34	52	57	40	38	47	446	51	42	33	22	11	7	166
Machinery manufacture	166	214	206	195	214	168	179	170	192	160	153	162	2,179	136	131	114	91	50	20	542
Metal mining and refining	54	58	57	53	66	52	48	44	41	40	38	52	603	45	41	35	36	27	17	201
Gas and coke	323	339	325	318	295	313	272	264	255	222	226	206	3,358	185	183	141	97	72	69	747
Electric power	357	314	281	359	335	280	285	359	337	327	279	192	3,705	180	196	141	71	36	9	633
Chemical industry	499	509	463	416	395	399	325	333	377	334	317	348	4,715	329	306	247	175	89	68	1,214
Ceramics, including cement	190	217	197	155	180	189	139	182	166	125	135	154	2,029	142	148	125	92	53	38	598
Fibre and textiles	116	114	129	89	81	88	60	71	75	64	61	78	1,026	76	70	63	51	43	52	355
Foodstuffs	40	67	81	62	59	70	40	53	66	43	48	55	684	49	52	50	36	35	46	268
Salt	22	29	48	25	28	40	32	26	24	15	20	22	331	18	20	22	23	42	44	169
Railroads	674	604	664	692	663	605	557	671	716	717	745	778	,086	767	760	618	571	398	316	3,430
Liquid fuel	114	131	121	117	126	121	124	128	145	143	149	154	1,573	149	153	143	98	41	22	606
Briquets	36	49	52	41	34	36	34	31	36	29	27	34	439	27	25	21	15	9	9	106
Non-industrial heating and cooking	115	155	221	253	221	223	166	171	149	95	108	149	2,026	77	125	182	180	218	348	1,130
Government factories and miscellaneous	56	90	106	85	78	113	73	98	103	109	102	122	1,135	91	109	99	78	57	89	523
Army	145	133	152	109	107	125	101	103	111	103	79	100	1,368	114	136	88	92	36	1	467
Navy	212	158	129	113	107	122	105	96	105	111	105	117	1,480	107	90	100	63	24	1	385
Ship bunkering	84	105	102	96	82	75	76	71	87	88	81	100	1,047	84	65	50	42	23	17	281
Total	4,365	4,484	4,500	4,256	4,091	3,886	3,526	3,824	3,916	3,519	3,402	3,702	47,471	3,331	3,346	2,859	2,268	1,486	1,296	14,586

Source: Compiled by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 36.—*Consumption of coal in Japan proper, by industries, excluding consumption by coal mines, in percentages of total consumption, monthly, April 1944–October 1945*

Industry	1944															1945							
	1st half							2nd half							1944	1st half							
	April	May	June	July	August	September	Average	October	November	December	January	February	March	Average	Average	April	May	June	July	August	September	Average	October
Iron and steel:																							
For coke	14.9	14.7	13.7	14.7	14.0	12.2	14.0	14.2	12.0	11.0	11.2	10.3	12.3	11.8	13.0	10.3	11.2	11.2	9.6	6.9	4.8	9.8	7.1
For fuel	11.1	11.3	11.5	9.9	10.2	9.4	10.6	10.6	11.6	11.3	10.2	10.0	10.2	10.7	10.7	10.8	9.5	9.3	9.6	8.0	4.7	9.2	4.2
Total	26.0	26.0	25.2	24.6	24.2	21.6	24.6	24.8	23.6	22.3	21.4	20.3	22.5	22.5	23.7	21.1	20.7	20.5	19.2	14.9	9.5	19.0	11.3
Shipbuilding	.6	.7	.7	.7	.7	.7	.7	1.0	1.4	1.5	1.1	1.1	1.3	1.2	.9	1.5	1.3	1.2	1.0	.7	.5	1.2	.5
Machinery manufacture	3.8	4.8	4.6	4.6	5.2	4.4	4.5	5.1	4.4	4.9	4.5	4.5	4.4	4.7	4.6	4.1	3.9	4.0	4.0	3.4	1.5	3.7	.8
Metal mining and refining	1.2	1.3	1.3	1.2	1.6	1.3	1.3	1.4	1.1	1.0	1.1	1.1	1.4	1.2	1.3	1.4	1.2	1.2	1.6	1.8	1.3	1.4	1.4
Gas and coke	7.4	7.6	7.2	7.5	7.2	8.1	7.5	7.7	6.9	6.5	6.3	6.6	5.6	6.6	7.1	5.6	5.5	4.9	4.3	4.8	5.3	5.1	7.2
Electric power	8.2	7.0	6.2	8.4	8.2	7.2	7.5	8.1	9.4	8.7	9.3	8.2	5.2	8.1	7.8	5.4	5.9	4.9	3.1	2.4	.7	4.4	.3
Chemical industry	11.5	11.4	10.3	9.8	9.7	10.3	10.5	9.2	8.7	9.6	9.5	9.3	9.4	9.3	9.9	9.9	9.1	8.6	7.7	6.0	5.3	8.3	6.5
Ceramics, including cement	4.4	4.8	4.4	3.6	4.4	4.9	4.4	3.9	4.7	4.2	3.6	4.0	4.1	4.1	4.3	4.3	4.4	4.5	4.0	3.6	2.9	4.1	3.1
Fibre and textiles	2.7	2.5	2.9	2.1	2.0	2.3	2.4	1.7	1.9	1.9	1.8	1.8	2.1	1.9	2.2	2.3	2.1	2.2	2.2	2.9	4.0	2.4	3.5
Foodstuffs	.9	1.5	1.8	1.4	1.5	1.8	1.5	1.1	1.4	1.7	1.2	1.4	1.5	1.4	1.4	1.5	1.6	1.7	1.6	2.4	3.5	1.8	2.8
Salt	.5	.6	1.1	.6	.7	1.0	.7	.9	.7	.7	.5	.6	.6	.6	.7	.5	.6	.8	1.0	2.8	3.4	1.2	2.2
Railroads	15.5	13.5	14.7	16.3	16.2	15.6	15.2	15.8	17.5	18.3	20.4	21.9	21.0	19.1	17.0	23.0	22.7	21.6	25.2	26.8	24.4	23.5	35.5
Liquid fuel	2.6	2.9	2.7	2.7	3.1	3.1	2.8	3.5	3.3	3.7	4.1	4.4	4.1	3.9	3.3	4.5	4.6	5.0	4.3	2.8	1.7	4.2	.7
Briquets	.8	1.1	1.1	1.0	.8	.9	.9	1.0	.8	.9	.8	.8	.9	.9	.9	.8	.7	.7	.7	.6	.7	.7	.7
Non-industrial heating and cooking	2.6	3.5	4.9	5.9	5.4	5.7	4.6	4.7	4.5	3.8	2.7	3.2	4.0	3.8	4.3	2.3	3.7	6.4	7.9	14.7	26.9	7.7	14.7
Government factories and miscellaneous	1.2	2.0	2.3	2.0	1.9	2.9	2.1	2.1	2.6	2.6	3.1	3.0	3.3	2.8	2.4	2.7	3.3	3.5	3.4	3.8	6.9	3.6	6.7
Army	3.3	3.0	3.4	2.6	2.6	3.2	3.0	2.9	2.7	2.8	2.9	2.3	2.7	2.7	2.9	3.4	4.1	3.1	4.1	2.4	.1	3.2	...
Navy	4.9	3.5	2.9	2.7	2.6	3.1	3.3	3.0	2.5	2.7	3.2	3.1	3.2	2.9	3.1	3.2	2.7	3.5	2.8	1.6	.1	2.6	..
Ship bunkering	1.9	2.3	2.3	2.3	2.0	1.9	2.5	2.1	1.9	2.2	2.5	2.4	2.7	2.3	2.2	2.5	1.9	1.7	1.9	1.6	1.3	1.9	2.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Compiled from data submitted by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 37.—*Army coal consumption in Japan proper, fiscal years 1940–45* [1]

[In thousands of metric tons]

Use	1940	1941	1942			1943			1944					1945	
			First half	Second half	Total	First half	Secood half	Total	I	II	III	IV	Total	I	II
Arsenals															
Ordnance	na	na	na	na	na	510	450	960	178	170	165	157	670	137	14
Air	na	na	na	na	na	76	67	143	26	25	25	23	99	23	2
Fuel	na	na	na	na	na	70	61	131	24	23	23	22	92	35	2
Clothing	na	na	na	na	na	106	93	199	37	35	34	33	139	41	4
Provision	na	na	na	na	na	61	54	115	21	20	20	19	80	3	1
Medical	na	na	na	na	na	1	1	2	.5	.5	.5	.5	2	.3	.3
Total	na	na	na	na	na	824	726	1,550	286.5	273.5	267.5	254.5	1,082	239.3	255.
Shipping	na	na	na	na	na	278	278	556	139	139	139	139	556	121	
Heating, etc	na	na	na	na	na	278	153	431	113	162	116	272	663	210	26
Grand total	1,339	2,233	1,632	1,743	3,375	1,380	1,157	2,537	538.5	574.5	522.5	665.5	2,301	570.3	519.

na Indicates data not available.

[1] These data on Army coal consumption were submitted by the Army Ministry and cannot be reconciled with the figures of cousumption in APPENDIX TABLE 33, submitte by the Japan Coal company. However, it is possible that some of the coal listed in the above table was classified differently in the Coal company's report.

Source: Compiled by the Military Affairs Bureau (Gummu Kyoku), November 1945.

APPENDIX TABLE 38.—*Comparison of coal allocated and consumed, by industries, quarterly fiscal year 1944*

[In thousands of metric tons]

Industry	First quarter		Second quarter		Third quarter		Fourth quarter		Total	
	Allocated	Consumed	Allocated	Consumed	Allocated	Consumed	Allocated	Consumed	Allocated	Consumed
Iron and steel	3,668	3,431	3,615	2,882	3,078	2,651	2,923	2,277	13,224	11,24
Shipbuilding, machinery and metal industry	612	681	792	660	616	684	578	600	2,598	2,62
Metal mining and refining	183	169	194	171	108	133	144	130	629	60
Gas and coke	904	987	1,064	926	920	791	909	654	3,797	3,35
Electric power	977	952	1,040	974	1,420	981	1,264	798	4,701	3,70
Chemical industry	1,590	1,471	1,895	1,210	1,597	1,035	1,519	999	6,601	4,71
Ceramics, including cement	544	604	761	524	740	487	668	414	2,653	2,02
Fibre and textiles	266	359	298	258	241	206	230	203	1,035	1,02
Foodstuffs	37	188	327	191	305	159	293	146	962	68
Salt	72	99	109	93	94	82	80	57	355	33
Railroads	2,117	1,942	2,144	1,960	2,102	1,944	2,270	2,240	8,633	8,08
Liquid fuel	459	366	486	364	471	397	642	446	2,058	1,57
Briquets	145	137	111	111	61	101	55	90	372	43
Non-industrial heating and cooking	-	491	705	697	396	486	379	352	1,480	2,02
Gas factories and miscellaneous	4	252	31	276	37	274	23	333	85	1,13
Army and Navy	1,010	929	1,230	683	1,346	621	1,252	615	4,838	2,84
Ship bunkering	527	291	472	253	308	234	314	269	1,621	1,04
Total	13,055	13,349	15,274	12,233	13,830	11,266	13,483	10,623	55,642	47,47

Source: Compiled from data submitted by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 39.—*Amounts and percentages of coal allocated to industries in Japan proper, semiannually for fiscal years 1943–4*

[In thousands of metric tons]

Industry	1943				1944				1945	
	First half		Second half		First half		Second half		First half	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Iron and steel	6,790	22.2	7,303	23.4	7,223	24.5	6,001	22.0	3,811	20.
Shipbuilding, machinery and metal industry	911	3.0	1,164	3.7	1,404	4.8	1,194	4.4	546	2.
Metal mining and refining	359	1.2	377	1.2	377	1.3	252	.9	195	1.
Gas and coke	1,838	6.0	1,942	6.1	1,968	6.7	1,829	6.7	1,180	6.
Electric power	2,616	8.6	2,953	9.5	2,017	6.8	2,684	9.8	1,230	6.
Chemical industry	2,825	9.3	2,999	9.6	3,485	11.8	3,117	11.4	1,994	10.
Ceramics, including cement	1,081	3.5	1,200	3.8	1,305	4.4	1,348	4.9	532	2.
Fibre and textiles	998	3.3	860	2.8	564	1.9	471	1.7	316	1.
Foodstuffs	167	.5	161	.5	364	1.2	598	2.2	253	1.
Salt	20	.1	82	.3	181	.6	174	.6	272	1.
Railroads	3,809	12.5	4,369	14.0	4,261	14.4	4,372	16.0	3,894	20.
Liquid fuel	712	2.3	847	2.7	945	3.2	1,113	4.1	1,022	5.
Briquets	531	1.7	592	1.9	256	.9	116	.4	28	.
Non-industrial heating, government factories and miscellaneous	3,779	12.4	2,827	9.0	1,908	6.5	825	3.0	814	4.
Army and Navy	2,505	8.2	2,166	6.9	2,240	7.6	2,598	9.5	2,212	11.
Ship bunkering	1,600	5.2	1,429	4.6	999	3.4	622	2.4	333	1.
Total	30,541	100.0	31,241	100.0	29,497	100.0	27,314	100.0	18,612	100.

Source: Compiled from data submitted by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 40.—*Allocation of coal in Japan proper, by districts, fiscal years 1943–45*

[In thousands of metric tons]

Year	Hokkaido		Eastern Honshu		Western Honshu		Kyushu		Total Amount
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	
43:									
First half	4,153	13.0	9,394	29.4	9,595	30.0	8,820	27.6	31,962
Second half	4,670	14.1	9,499	28.7	9,471	28.6	9,504	28.6	33,144
Total	8,823	13.6	18,893	29.0	19,066	29.2	18,324	28.2	65,106
44:									
I	2,117	14.1	4,092	27.2	4,236	28.2	4,597	30.5	15,042
II	2,562	16.0	4,379	27.3	4,257	26.5	4,837	30.2	16,035
Total	4,679	15.1	8,471	27.3	8,493	27.3	9,434	30.3	31,077
III	2,328	16.1	3,892	27.0	4,145	28.7	4,062	28.2	14,427
IV	2,350	16.7	3,656	25.9	3,953	28.0	4,151	29.4	14,110
Total	4,678	16.4	7,548	26.4	8,098	28.4	8,213	28.8	28,537
Total	9,357	15.7	16,019	26.9	16,591	27.8	17,647	29.6	59,614
45:									
I	2,126	20.6	2,539	24.6	2,764	26.8	2,883	28.0	10,312
II	2,007	21.8	1,904	20.7	2,102	22.9	3,186	34.6	9,199
Total	4,133	21.2	4,443	22.8	4,866	24.9	6,069	31.1	19,511
III	1,156	21.5	1,260	23.5	1,409	26.2	1,547	28.8	5,372

Source: Compiled from data submitted by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 41.—*Allocation of coal to iron and steel industry, by districts, fiscal years 1943–45*

[In thousands of metric tons]

Year	Hokkaido		Eastern Honshu		Western Honshu		Kyushu		Total Amount
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent	
1943:									
First half	758	11.2	1,763	26.0	1,649	24.2	2,620	38.6	6,790
Second half	933	12.8	1,985	27.2	1,708	23.4	2,677	36.6	7,303
Total	1,691	12.0	3,748	26.6	3,357	23.8	5,297	37.6	14,093
1944:									
I	449	12.4	1,052	29.2	828	22.9	1,279	35.5	3,608
II	482	13.3	947	26.2	845	23.4	1,341	37.1	3,615
Total	931	12.9	1,999	27.6	1,673	23.2	2,620	36.3	7,223
III	482	15.7	773	25.1	739	24.0	1,084	35.2	3,078
IV	436	14.9	745	25.5	646	22.1	1,096	37.5	2,923
Total	918	15.3	1,518	25.3	1,385	23.1	2,180	36.3	6,001
Total	1,849	14.0	3,517	26.6	3,058	23.1	4,800	36.3	13,224
1945:									
I	436	21.0	479	23.1	360	17.3	802	38.6	2,077
II	423	24.4	256	14.8	176	10.1	879	50.7	1,734
Total	859	22.5	735	19.3	536	14.1	1,681	44.1	3,811
III	107	14.8	124	17.2	128	17.8	362	50.2	721

Source: Compiled from data submitted by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

APPENDIX TABLE 42.—*Consumption of coal in Japan proper, by administrative regions, excluding consumption by coal mines, monthly, April 1944-September 1945*

[In thousands of metric tons]

Month	Hokkaido	Eastern Honshu				Western Honshu					Kyushu	Total	Deliveries[1] to railroads	Grand total
		Tohoku	Kanto	Tokai	Total	Kinki	Chugoku	Shikoku	Yamaguchi	Total				
1944														
April	461	169	614	200	983	635	147	124	272	1,178	1,069	3,691	674	4,365
May	476	113	694	219	1,026	643	173	83	290	1,189	1,189	3,880	604	4,484
June	610	121	670	234	1,025	590	171	145	209	1,115	1,086	3,836	664	4,500
July	663	120	598	197	915	497	147	139	226	1,009	977	3,564	692	4,256
August	562	200	597	176	973	502	153	115	240	1,010	883	3,428	663	4,091
September	564	140	560	156	856	531	169	92	237	1,029	832	3,281	605	3,886
October	494	104	457	141	702	464	130	102	245	941	832	2,969	557	3,526
November	476	100	401	201	702	544	143	90	246	1,023	952	3,153	671	3,824
December	395	111	437	186	734	581	124	100	261	1,066	1,005	3,200	716	3,916
January	293	96	345	152	593	433	128	79	243	883	1,033	2,802	717	3,519
February	315	95	325	167	587	364	118	79	252	813	942	2,657	745	3,402
March	479	125	333	156	614	400	124	102	253	879	952	2,924	778	3,702
Total	5,788	1,494	6,031	2,185	9,710	6,184	1,727	1,250	2,974	12,135	11,752	39,385	8,086	47,471
1945														
April	401	109	274	128	511	307	107	70	217	701	951	2,564	767	3,331
May	461	95	320	111	526	311	86	64	217	678	921	2,586	760	3,346
June	482	91	250	96	437	232	103	43	220	598	724	2,241	618	2,859
July	443	52	158	71	281	184	57	35	95	371	602	1,697	571	2,268
August	462	32	67	53	152	124	28	36	41	229	245	1,088	398	1,486
September	548	30	72	41	143	55	16	20	24	115	174	980	316	1,296
Total	2,797	409	1,141	500	2,050	1,213	397	268	814	2,692	3,617	11,156	3,430	14,586

[1] Coal consumed by Railway Bureau cannot be allotted to various regions.

Source: Compiled by the Japan Coal company (Nihon Sekitan Kaisha), November 1945.

ANNEX A

Coal Position of Karafuto, Korea, Manchukuo, Formosa, North China-Inner Mongolia, and Central China

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I

INTRODUCTION

On 15 June 1944, the strategic air assault against the productive vitals of the Japanese homeland got under way. Approximately 67 of the B-29's of the Twentieth Bomber Command from bases deep in Central China flew 1,400 miles to drop 95 tons of bombs over the giant Yawata works of the Japan Iron Manufacturing company, aiming at the vulnerable coke plants. During the next three months Allied plans to cripple the Japanese war potential by the destruction of the coke ovens of the steel industry continued to occupy the valiant, but painfully small-scale efforts of our B-29 bomber force in China.

By the fall of the year, the availability of new and larger-scale bases in the Marianas permitted the withdrawal of the China-based forces which had been facing insurmountable supply problems and operational difficulties. Concurrently, a reevaluation of strategic bombing policy resulted in the decision to shift the primary target system from the steel industry—because by then a considerable cushion of excess capacity was known to exist and for other reasons—to the aircraft, oil and other end-product industries, and the urban areas. From that time until the naval bombardment of the Wanishi and Kamaishi steel plants in Northern Japan in July and August 1945, the steel industry was not the primary objective of any air raids. However, the incendiary attacks against urban areas including industrial concentrations, rising to a crescendo in the summer of 1945, resulted in some damage to steel plants and to a minor extent affected steel production.

II

THE STEEL INDUSTRY BEFORE THE WAR

1. *Dependence on imports*

Japan long ago recognized that its undeveloped steel industry was the principal obstacle in the way of realizing its ambition to become a major industrial nation and to rate as a world military power. In fact, as recently as 1937 it ranked near the foot of the list of the chief industrial countries of the world in ingot steel production, as shown in Table 1.

TABLE 1.—*Major steel producers of the world, ingot steel production, 1937*

[In millions of metric tons]

Country	Ingot steel produced
United States	51.0
Germany (including the Saar)	19.8
U. S. S. R.	17.5
Great Britain	13.0
France	7.9
Japan Proper	5.8
Belgium	3.8
Czechoslovakia	2.3
Italy (1938)	2.3

Source: Stateman's Year Book, Macmillan and Co., Ltd. 1939.

But to achieve her dream of industrial greatness, Japan had to face the uncompromising fact that the country was pathetically deficient in the raw materials necessary for a large-scale, integrated iron and steel industry. Iron ore, high-quality coking coal, scrap iron and steel and ferro-alloy ores are the major items of which she was short and which did not exist within Japan in adequate quantities. Domestic supplies of limestone for fluxing were sufficient.

Iron ore imports were extremely vital because domestic production was small and also poor in quality. In 1937, when ingot steel production was only 5,800,000 tons,[1] imports accounted for 84 percent of the total iron ore consumed. An adequate local supply of coking coal presented a still more serious problem. Only small quantities of Hokkaido coal were of suitable quality for coking alone. Therefore, substantial imports of coal, primarily from North China, have always been absolutely essential for a large steel industry in Japan. The production of satisfactory coke was usually achieved by using a mixture of 70 percent domestic coal with 30 percent imported coal.

TABLE 2.—*Iron ore and scrap iron and steel imports related to consumption, fiscal years 1937 and 1940*

[In thousands of metric tons]

	1937			1940		
	Total consumed	Imports	Percent imported	Total consumed	Imports	Percent imported
Iron ore	5,121	4,313	84	6,986	5,719	82
Scrap iron and steel	4,394	2,420	55	4,405	1,391	32

Source: Appendix tables 4 and 8.

[1] Metric tons are used throughout.

The geographical location of the steel industry within Japan proper reflects this dependency upon imports and sea transport. Initially, plants were located in relation to sources of domestic raw materials. The Kamaishi plant—the first established in Japan (1874)—was located close to the northern Honshu iron mines; the Yawata plant (1901) was located close to Kyushu coal, and the Wanishi plant—completed during World War I—was located close to Hokkaido coal and iron ore. As the industry grew and imports became indispensable, new concentrations sprang up in the seaports of Central Honshu near to the steel-consuming centers of Kobe-Osaka, Nagoya, and Tokyo Bay.

The paucity of suitable domestic coking coal and iron ore, the two most necessary raw materials for the blast furnace, account for the heavy Japanese reliance on scrap instead of pig iron in the making of steel. It was the usual practice in the prewar period to use a 50-50 ratio of scrap to pig iron—or even higher—in the open hearth steel furnaces and almost all scrap in the electric steel furnaces. However, as Japan was still in its infancy, so to speak, in the use of steel, the outstanding, or installed, amount of steel from which an annual supply of scrap could be obtained was quite small. So, imports of scrap, which came mainly from the United States, were essential.

Similarly Japan has always relied on foreign sources for most of its ferro-alloy ores. Although production of domestic manganese, tungsten, chromium, and molybdenum ores was increased markedly between 1931 and 1941 (Appendix Table 20), that was not sufficient to provide for the country's expanding needs. Accordingly, the prewar ferro-alloy requirements of the Japanese steel industry could only be met by substantial imports of molybdenum, nickel, tungsten, vanadium, chromium, cobalt, and manganese ores and concentrates.

This lack of domestic raw materials, then, made the Japanese steel industry almost completely dependent upon water-borne imports. In modern military terms this can be characterized as high vulnerability to economic strangulation by blockade.

2. *Sources of raw materials imports*

The major prewar sources of the bulk raw materials for the steel industry in Japan proper are shown in Table 3 below and in Appendix Table 21 for the ferro-alloys. North China supplied almost all the imported coking coal—96 per cent of the imports in 1941. After the iron ore shipments from Malaya and the Philippines were stopped by economic embargo in 1941, China (including Hainan Island) also became the largest supplier of iron ore. Manchukuo, with its natural resources under Japanese control and exploitation, had a growing steel industry of its own and therefore was a noteworthy source of pig iron and some ingot steel. The steel industry of Korea was much less significant, but some pig iron and increasing amounts of iron ore were provided to Japan. The United States was the principal supplier of scrap iron and steel to Japan before the war.

TABLE 3.—*Major sources of raw material imports, fiscal years 1937 and 1941*

[Expressed as percentage of total imports]

Country	1937			1941		
	Coking coal	Iron ore	Pig iron	Coking coal	Iron ore	Pig iron
Karafuto	na	.....	.....	3	.....	.....
Korea	.....	7	12	.....	15	18
Manchukuo	na	.....	19	1	1	71
China	na	14	[1]	96	50	[1]
Philippines	.....	13	.....	.....	9	.....
Malaya	.....	38	.....	.....	23	.....
India	.....	.....	25	.....	.....	10
Other	.....	28	44	.....	2	1
Total	na	100	100	100	100	100
Amount (-000 metric tons)	na	4,313	1,131	3,417	5,058	784

na Indicates data not available.
[1] Less than 0.5 percent.

Source: Appendix Tables 1, 2, and 6.

3. *Steel-making equipment*

In the prewar period Japan had to rely heavily upon American, German, and British engineers and manufacturers of steel-making equipment if she wished to expand her industry. Coke ovens, blast furnaces, rolling mills and numerous important accessories were constructed or supplied, mainly by American concerns, right up to the embargo of 1940. Certain replacement parts, in turn, such as bearings and large rolls for rolling mills, had to be imported before the war from foreign sources. However, many Japanese engineers had journeyed to the United States and Germany ostensibly to purchase equipment, but at the same time to accumulate and absorb as much experience as possible. Thus by the time the war had started Japan had developed a capacity to supply much of her need in the field of heavy machinery and equipment.

4. *Expansion plans for steel*

As early as 1917, the Japanese government formulated far reaching policies aimed at creating a strong steel industry. Large scale expansion was encouraged

through tax concessions, subsidies and tariff protection. Later the government promoted cartels and sponsored transportation important to the steel industry. These policies succeeded in increasing ingot steel production to 1,883,000 tons in 1931.

Following the 'Manchurian Incident' in 1931, Japan greatly accelerated the expansion of all heavy industry, admittedly to provide the backbone of national defense. All of the plans for expansion emphasized two goals: (1) over-all expansion of capacity and production and (2) self-sufficiency within the Japanese sphere of influence. First, specific action in the steel industry took place in the creation in 1934 by the government of the Japan Iron Manufacturing company by compelling the merger of the seven leading concerns. This new steel giant was originally 76 per cent owned by the government, and from its inception reflected the policy of the government and acted in its name.

Second, the Iron Manufacturing Industry Law (effective September 1937) provided for the licensing of iron and steel producers and for government direction of all expansion in the industry. Colonel SATO, H., of the Military Affairs Section of the War Ministry, has commented on that law as follows:

> Whereas the purpose of steel controls had hitherto been the active fostering of the industrialists' interest, the newly enacted . . . law had as its primary object the rapid expansion of steel producing capacity and the creation of a self-sustaining steel industry . . . entering upon a period of military preparedness.

The primary production expansion plan, formally approved in January 1939, was the Cabinet Planning Board's embodiment of detailed plans for strengthening the critical industries. In it the expansion of steel capacity was given top priority. The period covered by the plan was five years, from 1938 through 1942. Its scope is shown in Table 4. Pig iron capacity was to be more than tripled, ingot-steel capacity was to be increased by 125 percent and finished-steel capacity by 85 percent in Japan proper, Korea, Manchukuo, and China.

TABLE 4.—*Five-year plan for the expansion of capacity of the Japanese iron and steel industry, fiscal years 1938–42*

[In millions of metric tons]

	1942—Capacity goal				Planned increase over 1937 capacity (in percent)			
	Japan and Korea	Manchukuo	China	Total	Japan and Korea	Manchukuo	China	Total
Pig iron	7.7	4.8	1.0	13.5	114	500	------	307
Ingot steel	12.7	3.6	.6	16.9	84	500	------	125
Finished steel	11.2	1.8	.5	13.5	62	350	------	85

Source: Compiled from data supplied by Iron and Steel Control association (Tekko Tosei Kai), October 1945.

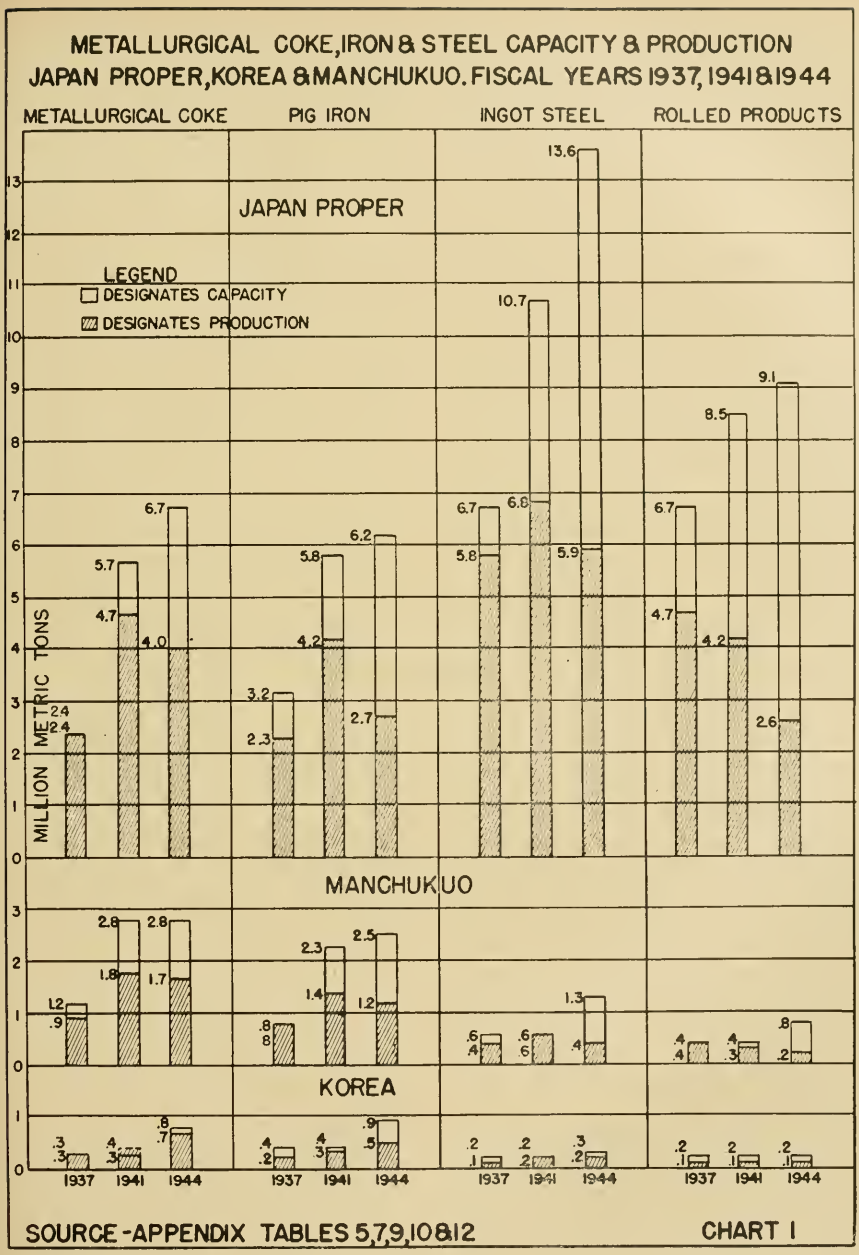
The problem of establishing self-sufficiency within the Japanese sphere of influence with regard to essential raw materials was principally one of substituting pig iron for scrap. The established practice of using a high ratio of scrap to pig iron in the manufacture of steel had made Japan very dependent upon potential enemies such as the United States. This explains the great emphasis in their plans on increasing pig-iron capacity.

A corollary of that design was to accumulate stockpiles of iron ore, scrap, manganese, and other ferro-alloy ores. The venture into China resulted in giving the Japanese direct control over their major source of raw materials and thus neatly fitted into their program of self-sufficiency.

5. *Success of expansion plans*

Although the war commenced fully a year before the end of the five-year expansion period, a remarkable degree of success had been achieved by 1941. The over-all expansion is shown in Chart 1. The total metallurgical coke and pig-iron capacity in Japan, Korea, and Manchukuo had more than doubled from 1937 to 1941. Significant, but smaller, gains were made in ingot-steel and rolled-steel products capacity.[1]

[1] Data on forged and cast-steel capacity for these earlier years are not available.


METALLURGICAL COKE, IRON & STEEL CAPACITY & PRODUCTION
JAPAN PROPER, KOREA & MANCHUKUO. FISCAL YEARS 1937, 1941 & 1944
METALLURGICAL COKE
PIG IRON
INGOT STEEL
ROLLED PRODUCTS
JAPAN PROPER
LEGEND
DESIGNATES CAPACITY
DESIGNATES PRODUCTION
MILLION METRIC TONS
MANCHUKUO
KOREA
1937
1941
1944
SOURCE-APPENDIX TABLES 5,7,9,10 & 12
CHART I

Increases in production during this prewar period were also substantial, although less spectacular than capacity expansion. In relation to the level from which they started, and considering the economic pressures exercised by the United States and Great Britain on the occasion of the Rome-Berlin-Tokyo pact in 1940, the Japanese had made great progress. But they still remained a minor industrial power in 1941, with an ingot-steel production of 7,600,000 tons as compared to the United States output of 74,000,000 tons in the same year.

The stockpiling effort met with only fair success. In June 1936 the government ordered the Yawata plant of the Japan Iron Manufacturing company to accumulate a stockpile for the nation of 3,000,000 tons of 55 percent iron ore and 115,000 tons of manganese ore over and above its normal requirements. The manganese ore stockpiling order was carried out. The iron ore stockpile, however, reached only 2,605,000 tons, and some of that had to be used before the beginning of the war to make up deficiencies in the supply from overseas. Stocks of scrap continued to grow until the embargo of October 1940.

TABLE 5.—*Stock-piles of iron ore and scrap iron and steel in Japan proper, as of end of fiscal years 1937–44*

[In thousands of metric tons]

Year	Iron ore	Scrap iron and steel
1937	4,151	4,509
1938	4,228	4,821
1939	3,952	5,791
1940	3,812	5,712
1941	2,605	4,468
1942	1,399	3,098
1943	792	1,437
1944	672	449

Source: Appendix Tables 4 and 8.

Stock pile data with respect to ferro-alloys and alloy metals could not be obtained in Japan, but Japanese officials freely admitted that the supply of nickel, which had been imported mainly from Canada, New Caledonia, Norway and Celebes Island, and also the supply of cobalt, which likewise came principally from Canada, was very tight even prior to the war.

6. *Government controls are applied*

The years 1937 to 1941, in addition to the expansion of facilities, witnessed as well the development within the iron and steel industry of a system of controlling production and the distribution of products which became the pattern for all wartime industry. The control agency evolved was an extension of the industry association formed earlier by the Japan Iron Manufacturing company and those major producers remaining outside that combination.

By late 1941 this industrialist-dominated Iron and Steel Control association (Tekko Tosei Kai) had—by government ordinance—been empowered (1) to allocate raw materials and production quotas, (2) to allocate equipment and dictate production details, (3) to control the management and finances of the industry, including the power to take over any concern, and (4) to administer the allocation of iron and steel products according to the national materials mobilizations plans decided upon by the Cabinet Planning Board. The absolute exercise of these powers was the province of the president of the Tosei Kai; that officer, however, was appointed by the Minister of Commerce and Industry and was subject to removal by him if the Tosei Kai's administration did not satisfy government policy.

7. *Steel consumption pattern, fiscal years 1937–41*

As early as 1938 the Japanese had, through the industry association, fixed steel prices and attempted to control the distribution of steel by the issuance of tickets against allotments made under the materials mobilization plans. That loose system, however, condoned certain flagrant leaks, most notably in that the armed forces did not need tickets. Further, the autonomy of the military services—who were not required to make available even to the Cabinet Planning Board any data concerning their stocks, receipts and consumption of steel—made it impossible to prepare an accurate statistical accounting upon which an informed and workable allocations system could be based.[1] By 1941, however, the system of controls over the distribution of steel, such as it was, had been fixed and had become the pattern for the nation's numerous materials allocations systems.

A comparison of total distribution with total supplies of steel (Appendix Table 16) shows that from the time the controlled allocations system was applied to ordinary rolled steel in 1938 until the beginning of the war the stock pile of finished steel was augmented by more than 1,000,000 tons. Complete stockpile data for the prewar and war years, however, were not available in Japan.

A comparison of the broad categories of steel use

[1] The data presented in Appendix Tables 14 and 15 on the consumption of steel must be considered with the warning that this characteristic inaccuracy of Japanese statistics is reflected in them. In compiling those tables, it was necessary to accept data supplied by the War, Navy and Munitions ministries concerning the steel available to the military. Data supplied by the Iron and Steel Control association have been used in compiling figures concerning steel distribution to civilian ticket holders.

in the five years before Pearl Harbor (Appendix Table 15) shows how heavily Japan was committing steel to the effort to broaden her industrial base. In 1937 about 44 per cent of all rolled ordinary steel was devoted to the building of industrial facilities, the manufacture of machinery and tools, and to public works and construction. In 1938 amounts of rolled ordinary steel going to those uses declined somewhat, but still held at a high level (32 per cent) and remained relatively constant for the next two years (33 and 31 per cent respectively). In 1941, however, a further drop to 24 per cent took place as the pressure for steel for immediate use was felt and as plant expansion programs approached completion.

Similar comparisons of steel going to the armed services indicate the accumulative pressure of the armament program and the war in China, for the military percentage increased from 18 per cent in 1937 to 37 per cent in 1940 and 49 per cent in 1941. It must also be recognized, however, that during this period a considerable portion of the military allocation was going into the expansion of arsenals and productive facilities; further, approximately one-third of the "manufactured goods" category was finding its way into industrial facilities, and 37 per cent of that category was consumed by the military in 1940.

The relative importance of the steel industry itself as a consumer is indicated by the fact that its distributive share of total rolled ordinary steel was eight per cent in 1939 and seven per cent in 1940. A sharp decline—to two per cent—occurred in 1941 which continued in 1942, because deliveries to erection sites in the steel industry's expansion program had been nearly completed, although the plants under construction had not yet come into production.

The large export item in 1937 (13 per cent of rolled ordinary steel) reflected the contribution of Japan proper to the expansion of facilities in her old and newly acquired territories, but by 1941 exports had fallen to eight per cent and thereafter gradually disappeared. Approximately 50 per cent of exports went to Manchukuo and North China.

III

THE WAR PERIOD

1. *Steel goes to war*

By the end of 1941 the production expansion plan had been very nearly accomplished and had added significant capacity in all major departments of the steel industry. The proportionately greater expansion in coke and pig iron facilities in Japan proper, Korea, Manchukuo and China, moreover, had provided a balanced capacity, which, if adequately supplied with raw materials, would have enabled pig iron largely to replace previously essential scrap imports. However, the lack of balance as between Japan proper and the mainland had been accentuated. The steel-making and steel-rolling capacity was concentrated in Japan proper (89 and 91 per cent respectively in 1944) whereas only 59 per cent of the pig iron capacity was located there (Table 6). Full operation of the steel furnaces required the moving of the mainland surplus of pig iron by sea to Japan proper.

Within Japan proper the industry was characterized by a high concentration of capacity in a relatively few large plants, with a considerable dispersion of remaining capacity in smaller plants.

TABLE 6.—*Geographical distribution of 1944 metallurgical coke, iron and steel capacity*

[Expressed as per cent of total]

Area	Metallurgical coke	Pig iron	Ingot steel	Rolled products
Japan proper:				
Hokkaido	11	11	7	2
Honshu	28	24	63	60
Kyushu	26	24	19	29
Total	65	59	89	91
Korea	8	9	2	2
Manchukuo	27	24	9	7
China	0a	8		
Total	100	100	100	100
Amount (-000 tons)	(10,345)	10,498	15,284	10,072

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

Source: Appendix Table 10 and data supplied by Iron and Steel Control association (Tekko Tosei Kai), November 1945.

For example, the nine largest plants (two on Kyushu, one on Hokkaido, and six on Honshu) accounted for 99 per cent of coking capacity, 99 per cent of pig iron capacity, 50 per cent of ingot capacity and 58 per cent of rolling capacity in the home islands. Electric furnace capacity and casting and forging capacity were widely scattered among many small plants.

Production had increased along with the growth in capacity, but in a smaller degree. From 1937 to 1941 pig iron production had grown by more than 80 per cent; but the output of ingot steel was only 17 per cent greater and finished steel output had remained unchanged. This naturally meant that unused capacity in the industry had increased. Although pig iron production in 1941 continued at about 72 per cent of capacity, ingot steel output declined from 85 per cent in 1937 to 64 per cent of capacity in 1941.

The phenomenon of substantial—and growing—excess capacity, especially in the steel-making and steel-finishing end of the industry, is readily explained. In the first place, the increased production of pig iron merely substituted for imported scrap which no longer could be obtained from the United States and other foreign sources. Secondly, to operate the enlarged industry at capacity would have required imports of iron ore to Japan of close to 10,000,000 tons; yet in 1941 the Philippine and Malayan ores had been largely denied the Japanese, and they had only succeeded in bringing in slightly more than half of their requirements. Finally, the tonnage of shipping required for any given level of steel production had greatly increased as a result of the conversion from a high scrap process to a pig iron process. To produce the equivalent in pig iron of one ton of imported scrap would require from two to three tons of iron ore and coking coal imports.

The significant feature of the "new" Japanese steel industry was that, in eradicating dependence on one kind of import, it had become vastly more dependent on water-borne transportation itself and on the availability of much greater amounts of iron ore and coal within Japan's sphere of influence. The planners had been unable to escape from their dilemma.

2. *Attack on raw materials and countermeasures*

As Japan's economic adventure gained momentum, it was against her vulnerable raw materials position that Allied sanctions were applied. The scrap embargo belatedly enforced by the United States in October 1940 was the first serious blow. This was the eventuality against which Japan had sought to prepare itself by the development of new pig iron capacity. In June 1941 Japanese troops marched into French Indo-China. The United States and the Allies retaliated with a complete economic embargo which, among other things, deprived Japanese blast furnaces of the superior iron ores from the Philippines and Malaya, accounting in 1940 for 57 per cent of total ore imports between them.

As a result, all-out efforts were immediately concentrated on developing China, mainly the Yangtze Valley, and Hainan Island as substitute sources for ore. This program also was successful at first, despite its hindrance by Chinese guerrilla activity. Iron ore imports from China and Hainan were increased from 1,175,000 tons in 1940 to over 2,500,000 tons in 1941 and to nearly 4,000,000 tons the following year. Despite those increases, however, total iron ore imports to Japan in 1941 fell 660,000 tons short of the 1940 peak and about 840,000 tons short in 1942.

The raw materials embargo was lifted by the success of Japanese arms. By mid-1942 there had been brought under Japanese control most of the areas —notably the Philippines and Malaya—upon which Japan had earlier relied so heavily for raw materials. Almost at once it developed, however, that the shipping requirements for military operations would make it impossible to consolidate these gains. Imports from the Philippines and Malaya (Appendix Table 2) never reached even 200,000 tons in any war year, as compared with 3,259,800 tons in 1940.

After 1942 the history of how Japanese steel production was whittled down and brought to a near standstill at the time of surrender is almost wholly the account of the attack on the flow of raw materials via shipping. The ultimate effect in raw material imports is shown in Table 7. It will be noted that scrap imports—as a result of the 1940 embargo—had nearly stopped before the shipping shortage became acute. Pig iron receipts were little affected until 1945 because of the tremendous saving in shipping which they represent over their equivalent in raw materials.

TABLE 7.—*Coking coal, iron ore, pig iron, and scrap iron and steel imports to Japan proper, fiscal years 1941–45*

[In thousands of metric tons]

Year	Coking coal	Iron ore	Pig iron	Scrap iron and steel
1941	3,417	5,058	784	20
1942	4,025	4,880	878	3
1943	2,939	3,686	1,134	2
1944	1,435	1,668	942	7
1945	116	143	51	

Source: Appendix Tables 1, 2, 6, and 8.

Details of the Allied attacks on shipping will be found in other Survey reports. It should be noted, however, that because the steel industry bulked so large as a user of sea transportation, every new diffi-

culty which occurred in shipping created an almost immediate crisis in the steel industry.

At the time of the Guadalcanal relief operations in November 1942, the authorities in Tokyo recognized that the allocations of merchant shipping demanded by the Army and Navy threatened the whole steel production schedule. So, in January 1943, the following Army-proposed transportation-saving countermeasures were put into effect with varying success:

a. Iron ore production in Japan proper, despite its lower quality, was to be expanded. The success of this measure is indicated by a production rise from nearly 2,800,000 tons in 1942 to over 3,600,000 tons in 1943 and to better than 4,400,000 tons in 1944.

b. Iron ore production was also to be expanded as rapidly as possible at the low-grade Mozan mines in northeastern Korea as it would require a minimum of transportation and could move across the relatively safe Japan Sea. This step was moderately successfully; iron ore imports from Korea increased from 255,000 tons of 51 per cent concentrates in 1943 to 610,000 tons of 54 per cent concentrates in 1944.

c. Iron sands production at home and technological research concerning its use in the manufacture of sponge iron and pig iron was to be hastened. The negligible success of this countermeasure is evident in the small increase in production; only 368,000 tons were mined in 1942, some 430,000 tons in 1943 and 480,000 tons in 1944, despite the large deposits at hand. Difficult-to-remove impurities, especially titanium, narrowly restricted the use of that plentiful source of iron.

d. The most conspicuous failure in the program, though, was the much-heralded small blast furnace effort. In December 1942, the Cabinet council decided to establish quickly about 160 small-type (mainly 20-ton) blast furnaces with a total rated capacity of 1,000,000 tons a year in China, Inner Mongolia, Korea, and Formosa, near the sources of raw materials. In this way precious transportation was to be conserved by shipping pig iron to Japan instead of the equivalent in raw materials which weighed from two to three times as much. Secondarily, the danger from air raids was also to be minimized by the resulting dispersal of production.

The advantages of the small blast furnace were supposed to be that the furnaces could be mass-manufactured with a minimum of scarce materials because of the uncomplicated design; installation could be rapidly accomplished because no heavy equipment would be required; operation would be simpler and much of the labor could be unskilled

In practice, almost everything went wrong; the furnaces were an anachronism in metallurgical history. In relation to rated output and materials consumed, the small blast furnaces were actually far less economical than large furnaces. Technologically, the design hardly surpassed early 18th century occidental practice. In fact, unusual skill would have been called for if the furnaces were to operate successfully. The life of the equipment was short; the output was small and so poor in quality that no Japanese steelmaker wanted to use the pig iron (they did so reluctantly, or they treated the iron as high-grade ore and passed it through their blast furnaces again). Labor requirements were out of reason; coke consumption was exorbitant.

As a result of tremendous effort, 117 furnaces with about 730,000 tons of annual capacity were installed by the end of 1944, and in the peak quarter production reached 86,000 tons of pig iron. However, before the end of the war many of the small blast furnaces, particularly in China and Formosa, had been abandoned.

e. A stepped-up use of coking coal from the Mishan deposits in northeast Manchukuo was intended to replace North China water-borne shipments to steel mills both at Anshan in western Manchukuo and in Japan proper. The movements to Anshan would be by rail, and the shipments to Japan could be moved from Rashin and Seishin, Korea, across the Japan Sea to Hokkaido and northern Honshu. Imports to Japan did increase from 5,000 tons in 1943 to 124,000 tons in 1944, still a very small amount. But, a reduction in receipts at Anshan after this shift negated the benefits and operated as a limiting factor on production at the plants there.

f. Coking-coal and iron-ore production in Hokkaido were to be increased so as to make the steel industry on the island self-sufficient. The Wanishi plant of Japan Iron Manufacturing company did, in fact, become nearly self-sufficient. The quality of coke produced with local coal alone was so poor, however, that iron output decreased disastrously, and even the quality of pig iron declined so that it was in large part unusable at the neighboring Muroran armament plant.

The necessity for the foregoing countermeasures to economize on sea transport for the steel industry was further high-lighted by shipping losses in 1943 owing to the extension of the submarine campaign into the Yellow Sea. With the loss of the Marshalls

and Gilberts in February 1944, the resultant increase in ship losses and in demands for merchant ships by the military required that the line of sea transportation of essential raw materials be still further shortened. The movement of coal from China by rail through Manchukuo, Korea, and across the Shimonoseki Straits was substituted for the precarious direct voyage. The capacity of the rail lines soon proved insufficient to replace more than a part of the water movements, and, as indicated in Table 7, coal imports further declined.

Ship sinkings in 1944—with Allied land-based and carrier planes adding to the toll being taken by submarines—were beyond the most pessimistic expectations of the Japanese. Further, the raids of the Fourteenth AF based in China on Yangtze River shipping and the virtual isolation of Hainan Island accentuated the precipitous fall of raw material imports. In 1944, moreover, receipts of pig iron in Japan began to decline, despite no similar decline in production levels in Korea, Manchukuo, and China. Late in the year, stocks of iron ore at the mines and at loading points on the mainland had piled up so that practically all further mining operations were abandoned. The important Tayeh and Maanshan iron districts on the Yangtze River ceased operations after February 1945, by which time well over 1,000,000 tons of ore had accumulated at river landings.

3. *Too little and too late*

Early in 1945 the Japanese in desperation undertook to move a considerable amount of iron and steel-making equipment to the sources of raw materials in Manchukuo, Korea and North China. This dispersal was essentially intended to reduce the burden on shipping rather than as protection against bombing. The most important single effort was the removal of the Osaka plant (steel-making and rolling) of the Japan Iron Manufacturing company to Seishin, Korea. The plant was completely dismantled in the spring of 1945. Part of the equipment finally reached Seishin; some of it was sunk on the way, and at the end of the war crated pieces of machinery still remained at the old site. The Fuji plants of the Japan Iron Manufacturing company was likewise disassembled, and it was intended that it be re-erected at Tangshan in Hopei Province, the site of a small blast furnace plant. Other large items were to be moved to Tungpientao, Tunghua Province and Anshan (both in Manchukuo), as well as to Shihchingshan, near Pekin in North China.

By that time, however, practically all of Japanese officialdom sensed that the disruption and attrition of shipping was so severe that these plans stood little chance of success. The first B–29 raids, in June and July 1944, against the Yawata works in Japan and the Anshan works in Manchukuo had signalled the beginning of the strategic bombing program. The urban area raids, increasing in tempo rapidly after March 1945, further aggravated the already bad situation. But the timing of their impact was too late to have a serious influence on the steel industry. The effects of those raids will be discussed later, but the continuing attack on the flow of raw materials to the islands of Japan remained the most important factor in throttling production.

The air-borne mining of Japanese and Korean ports and of the Shimonoseki Straits beginning in early April 1945 killed the hopes of the steel industry. That was recognized in May when at the high-policy level it was decided that only foodstuffs and salt were thereafter to be imported from the mainland. Any further production was now dependent upon the insignificant stock piles of raw materials and domestic production of low-grade iron ore and coal.

The combined results of all attempted countermeasures had been insufficient either to withhold or to offset the ever-accelerating decline in raw materials receipts. Thus, total iron ore, which, if the Japanese had been willing to consume their entire stock pile in any year, might have been available for blast furnace charges, declined as follows—not taking into account reduced iron content:

TABLE 8.—*Supply of iron ore and requirements for capacity operation of blast furnaces in Japon proper, fiscal years 1940–45.*

[In thousands of metric tons]

Year	Full capacity requirements [1]	Iron ore supply			Actual consumption
		Stock pile beginning of year	Total receipts	Total available	
1940	na	3,952	6,846	10,798	6,986
1941	10,567	3,812	6,625	10,437	7,832
1942	10,567	2,605	7,669	10,274	8,875
1943	10,567	1,399	7,524	8,923	8,131
1944	11,313	792	6,077	6,869	6,197
1945:					
1	na	672	980	1,652	na

na Indicates data not available.
[1] Assuming 55 per cent Fe content of ore and 100 per cent recovery of iron content.

Source: Appendix Tables 4 and 10.

Similarly, coke production was down from 5,483,000 tons in 1942 to 72 per cent of that tonnage in 1944 and to a rate of 33 per cent in 1945. But the drop in output was not the worst of it, as the disas-

trous reduction in quality which resulted from increasing use of domestic coal made much of the coke unusable in blast furnaces. Imports of coking coal had dwindled in 1944 to 41 per cent of the 1941 level and in 1945 to a rate of 14 per cent.

4. *Capacity versus production*

As has already been pointed out, Japan started the war one year before the completion of her capacity expansion plan. But even at the 1941 status of completion, shortages of raw materials had made some of this capacity surplus in relation to the rate of production which Japan proper was able to support in 1941 on the available raw materials. For example, the pig iron production rate in 1941, although 182 per cent of the 1937 rate, was only 72 per cent of rated capacity. Ingot steel output in 1941 was 117 per cent of the 1937 rate, but was only 64 per cent of rated capacity. And rolled steel production—down to 89 per cent of the 1937 rate—was a mere 49 per cent of rated capacity. Despite this, even after the beginning of the war, capacity continued to increase. Thus, during the war, in Japan proper coking capacity increased by 19 per cent, pig iron capacity by 7 per cent, ingot steel capacity by 27 per cent, and rolling capacity by 7 per cent. Much of this construction had been under way when the war started and was pushed to completion because the eternally optimistic Japanese for a long time expected the raw materials problem to be solved.

The large expansion of ingot steel capacity is accounted for mostly by the doubling of electric steel capacity, although additional open-hearths were installed in the big Japan Iron Manufacturing company plants.

The new rolling capacity marked the beginning of operations in December 1942 at the modern, high-speed plate mill at Hirohata, a significant addition to capacity inasmuch as steel plates were badly needed for the expanding shipbuilding program.

Outside of Japan proper additional increases in capacity resulted from the completion of the second open-hearth plant at Anshan, Manchukuo, and the previously mentioned construction of many small blast furnaces in Korea and China. The widely publicized development at Tungpientao in Manchukuo—where there were supposed to be large deposits of high-grade iron ore and coking coal readily available—proved a great disappointment to the Japanese.

The deposits turned out to be scattered, difficult to mine and not as rich as thought. As a consequence, all construction work there was allowed to lapse.

The production pattern of the iron and steel industry during the war is shown in Chart 2. The peak was reached in 1943 when ingot steel climbed to a level of 14 per cent higher, and finished steel 10 per cent higher, than in 1941.

The emphasis on the production of special steel, urgently needed by the aircraft and munitions industries, is reflected in Chart 3. Despite a decline in total ingot steel production from mid-1943, electric furnace output was maintained at a high level until the end.

As has been noted earlier, the flow of imported raw materials was beginning to decrease early in 1943, and the high level of steel production was maintained only by the rapid depletion of raw material stock piles. Coke and pig iron production had started to slide downward early in 1942. As shown in Table 9, steel production rapidly declined after 1943 and by June of 1945 had been cut down to 25 per cent of its wartime peak.

TABLE 9.—*Metallurgical coke, pig iron, ingot steel, and finished steel production, Japan proper, fiscal years 1941–45*

[In thousands of metric tons]

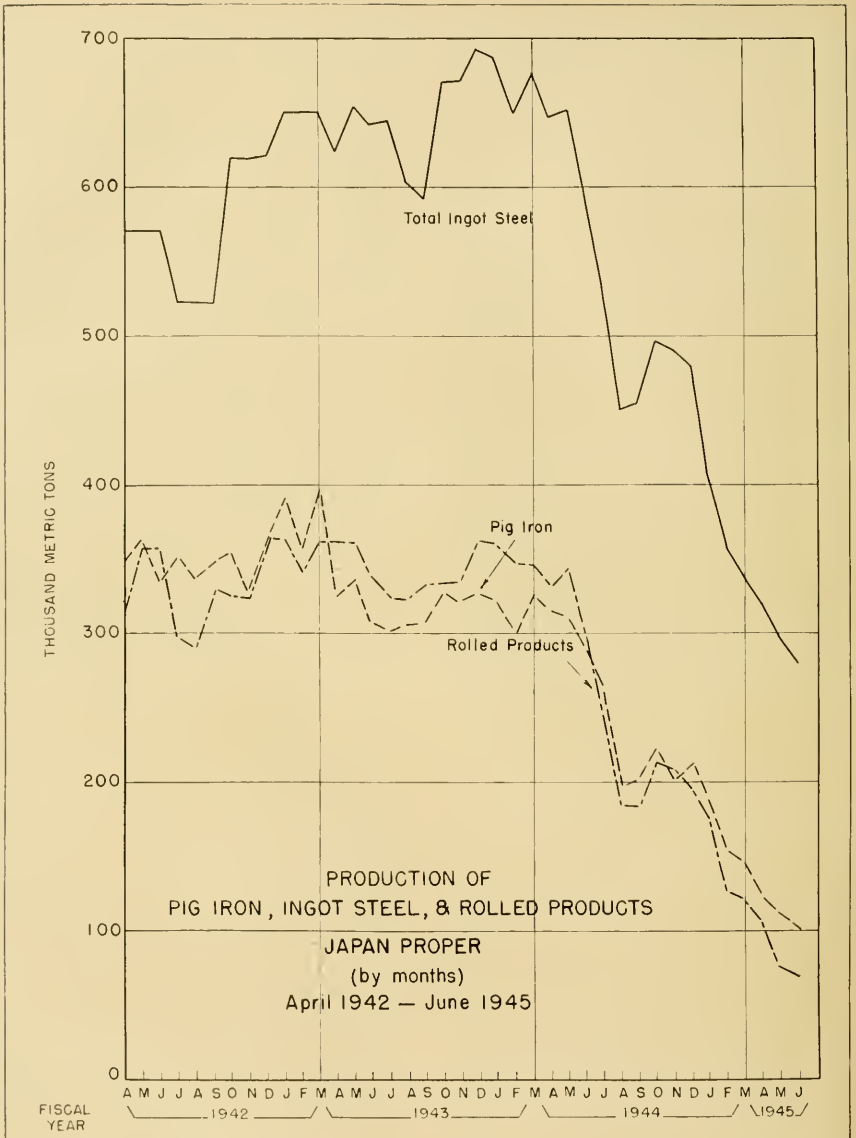
Year	Metallurgical coke	Pig iron	Ingot steel	Finished steel
1941	4,691	4,198	6,837	5,120
1942	5,483	4,306	7,099	5,166
1943	5,158	3,813	7,821	5,615
1944	3,980	2,713	5,911	4,320
1945:				
I	458	340	803	492

Source: Appendix Tables 5, 7, 9, and 12.

5. *Special steels and ferro-alloys*

Special steel production during the war years differs from that of the rest of the industry in that output rose during the period at a steady and rapid rate to a peak of 1,185,000 tons of finished steel in 1944 (Appendix Table 26). Further, in the production of ferro-alloys and special steel, the limiting factor of inadequate furnace capacity was added to the shortages of essential ferro-alloy ores (Appendix Table 21). Japan was almost entirely dependent upon imports for her supplies of cobalt, nickel and tungsten ores and, to a lesser extent, for molybdenum, chrome and manganese ores.

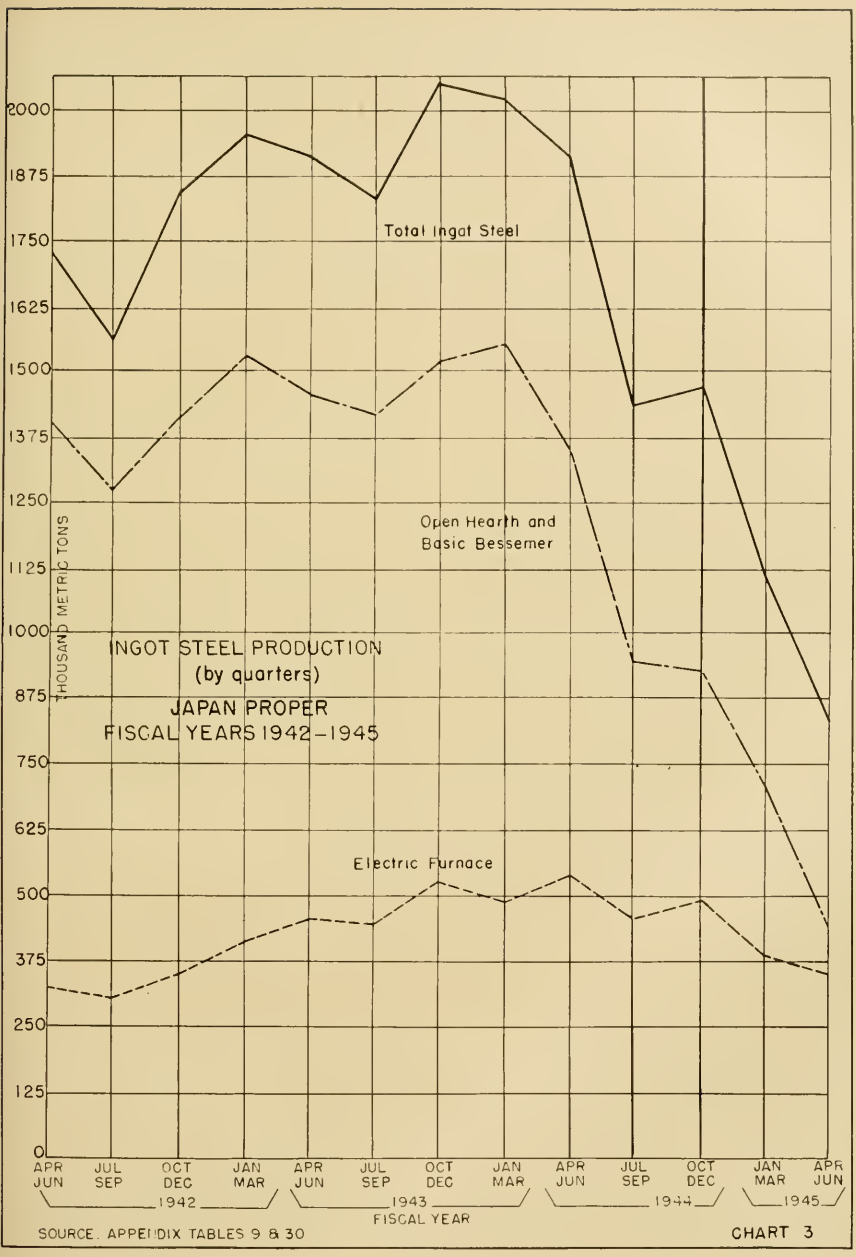
Cut off by the war from the richer Indian manganese ores, Japan was able to maintain its imports of lower grade Philippine ores at 20,000 tons annually until 1944, and had to turn to increased



SOURCE APPENDIX TABLES 9 & 30

MONTHLY INGOT STEEL PRODUCTION FIGURES ESTIMATED BY PRORATING ELECTRIC STEEL QUARTERLY FIGURES FOR THE ENTIRE PERIOD AND PRORATING OPEN HEARTH AND BASIC BESSEMER QUARTERLY FIGURES FOR FISCAL YEAR 1942.

CHART 2


2000
1875
1750
1625
1500
1375
1250
1125
1000
875
750
625
500
375
250
125
0
THOUSAND METRIC TONS
Total Ingot Steel
Open Hearth and
Basic Bessemer
Electric Furnace
INGOT STEEL PRODUCTION
(by quarters)
JAPAN PROPER
FISCAL YEARS 1942–1945
APR JUN
JUL SEP
OCT DEC
JAN MAR
APR JUN
JUL SEP
OCT DEC
JAN MAR
APR JUN
JUL SEP
OCT DEC
JAN MAR
APR JUN
1942
1943
1944
1945
FISCAL YEAR
SOURCE. APPENDIX TABLES 9 & 30
CHART 3

domestic production which rose from 196,000 tons in 1941 to 401,000 tons in 1944. As a consequence of using much lower-grade ores, however, the quality of the ferro-manganese produced deteriorated, and electric furnace capacity failed to keep up with mounting needs. Moreover, the shortage of ferro-manganese, coming on top of the necessity to use low-grade iron ores having a high sulphur content, produced incomplete de-sulphurization of steel.

Since about 1943, and growing increasingly worse as the war progressed, the supply of ferro-silicon was inadequate to meet demands—in spite of the fact that there was no shortage of siliceous materials. Consuming more electric power than any other ferro-alloy, the production of ferro-silicon was particularly affected by inadequate electric furnace capacity. The production of electrical sheets (essential in manufacturing electrical machinery) was inadequate to meet requirements after 1941. As a result, in 1943 the makers of electrical machinery were unable to complete equipment that was indispensable to almost all industrical plants.

Although domestic production of ferro-chromium increased by 50 per cent from 1941 to 1943, output was not sufficient to meet the increased military demands. Japanese experts have estimated that only 90 per cent of the requirements could be met by 1942, and by 1943 only 60 per cent. Dwindling tungsten imports from China, Burma, and Thailand, and an increased need for high-speed, magnet, and die steels brought about a shortage of about 35 per cent in ferro-tungsten as early as 1942.

With little or no domestic production of molybdenum ores, supplemented only by insignificant imports of concentrates from Manchukuo, Japan was unable to meet its ferro-molybdenum needs by 1942, and after that continued to experience a shortage of about one-third of its requirements as existing stocks were stretched out. A shortage of ferro-vanadium developed at about the same time because of the complete lack of domestic vanadium ores and the loss of American and Peruvian imports. Except for a small amount of ore received from Manchukuo in 1944, there were no imports after 1940.

Supplies of every important ferro-alloy were short of military requirements after the outbreak of the war in 1941, and became worse as the war progressed. By August 1945, stocks on hand of the various ferro-alloys were only from one to three months' supply even on the basis of the low production rate of January-March 1945. The directors of the Special Steel Section of the Iron and Steel Control association estimated the relation of supplies of alloying elements to requirements as follows:

TABLE 10.—*Per cent of requirements of alloying elements available in Japan proper, fiscal years 1940–45*

Element	Per cent of requirements available					
	1940	1941	1942	1943	1944	1945
Cobalt	50	20	10	5	5	5
Nickel	60	30	20	10	10	10
Tungsten	100	100	65	65	65	65
Molybdenum	100	100	65	65	65	65
Vanadium	100	100	70	70	70	70
Chromium	100	100	90	60	60	60
Manganese	100	100	100	100	70	70
Silicon	100	100	100	100	72	70

Source: Iron and Steel Control association (Tekkō Tosei Kai), November 1945.

The shortages of ferro-alloys made it necessary to resort to (1) an extensive program of reduction of the alloy content of various alloy steels, and (2) widespread substitutions of one element or combination of elements for another. The serious cobalt and nickel shortages—already quite marked even before 1941—grew even worse as the war progressed, and never improved. High speed steels formerly containing up to 16 per cent cobalt were no longer produced, and steels without cobalt substituted. By 1943 chrome-nickel stainless steel of the "18–8" type had to be made without nickel, and later it even became necessary to reduce the chrome content to 13 per cent. Structural steel which normally contained molbydenum was made without it when molybdenum ran short and no satisfactory substitute was at hand. The nickel content of such important military materials as gun-barrels, thin armor-plate, and torpedo air-chambers had to be reduced, sometimes successively.

Substitutability of elements was pressed as far as possible. In fulfilling air forces requirements, chrome-nickel steel was early replaced by manganese-chrome-molybdenum steel, and that in turn by silicon-manganese-chrome steel in March 1943. Nickel steel was replaced by silicon-manganese-chrome steel, and in June 1945 its replacement by straight high-carbon steel was being tested. The extent of substitution of high-carbon steel for alloy steel is indicated in the increasing proportions of high-carbon to total special steel produced: 37 per cent in 1942, 39 per cent in 1943, and 50 per cent in 1944. The majority of Japanese metallurgists interviewed, moreover, asserted with some vehemence that they had obtained no help from Germany in solving their difficulties, this despite the fact that trained technicians of the Japan Iron Manufacturing

and other companies were in Germany throughout the war. German scientists, facing many of the same obstacles, had successfully overcome shortages of alloys by developing heat-treating to a high art; but the Japanese had been unable to get the details of those techniques, or, when they infrequently did, could not put them into practice.

The problem of insufficient electric furnace capacity was partially solved by an increase in capacity during the years 1941–1944. In addition, spiegeleisen (low-grade ferro-manganese) was produced in blast furnaces at Yawata and Wanishi and some carbide furnaces were converted to ferro-silicon production.

5. *Technical operating difficulties*

In the early years of the war no insurmountable technical obstacles confronted the iron and steel industry; raw materials were available in quantities adequate for normal operating practises. In fact, as considerable amount of new capacity first came into operation during those years, productive efficiency reached higher levels than had prevailed before 1941. Specifications for finished steel were stiffened measurably during the period, but the principal result was to increase rejections and the subsequent supply of scrap. Evidence of this is found in the fact that during 1941–43 ingot-steel production increased to its highest level while the quantity of delivered products increased at a much lesser rate.

Without Philippine, Malayan or Yangtze Valley ore after the summer of 1944, however, ores with higher silicon and sulphur content (especially pyrite cinters) and with lower iron content were perforce used. The effect was (1) greatly to increase slagging requirements in the blast furnaces (for instance, at Yawata slag produced per ton of iron rose from 350 kg in April 1944 to 1230 kg a year later) and (2) to skyrocket the residual quantities of silicon and sulphur in the iron, because of the shortage of manganese. At Hirohata, the largest new plant in Japan, silicon content of pig averaged 0.92 per cent in April 1944 (already a high figure), but by February 1945 the average had risen to 2.15 per cent and by August to 4.95 per cent, an intolerable level for normal steel production.

Although the Japanese have always operated with relatively poor coke by U.S. standards, the loss of North China coking coal forced the substitution of poorer grade Manchukuoan coals and the greater use of domestic coals which are weaker in caking power and higher in ash. At Yawata, for instance, average ash content of the metallurgical coke rose from about 19.7 per cent in April 1945 to about 23 per cent two years later when the admixture of Chinese coal had declined to nine per cent. The ratio of coke consumed per ton of pit iron became greater and thereby lowered smelting capacity. Using Yawata again as an example, that ratio increased from 1.0 in 1942 to 1.3 in 1945 (Appendix Table 28). Besides increasing slagging needs, the poorer coke carried further sulphur to the iron.

Plant engineers have testified that no particular problems were encountered in the early part of the war with respect to items of equipment formerly obtained abroad, such as rolls, medium and large bearings, and lubricants. Supplies on hand accounted for normal requirements, and in most cases Japanese manufacturers produced satisfactory, if less durable and accurate, substitute parts. However, by 1944, individual works were frequently hindered seriously by shortages of many items and by abnormal operating interruptions. Electrical equipment, high pressure greases and oils, hand tools, acetylene, leather for bearing seals, valves, and other unpredictable parts and supplies have been stated to have caused noticeable production losses.

Essential refractories troubled the iron and steel plants, but did not become critical until 1943. The quantities needed were usually available, but quality deteriorated markedly after imports of western refractory materials and prefabricated linings ceased. At first—because of excess capacity—this occasioned no serious inconveniences, although the necessity for more frequent shutdowns of furnaces, both iron and steel, and the increased amounts of impurities transmitted to the molten metal affected the efficient flow of materials and increased the number of rejected heats. By 1944, however, the coinciding of greater refining burdens on the steel furnaces with progressively poorer refractories (1) cut the life of linings by as much as 50–60 per cent by late 1944, (2) extended open-hearth furnace cycles from around 8 hours on the average early in the war to 13–15 hours per heat, and (3) sharply increased heat consumption per ton of ingot produced.[1] Numerous refractory failures resulted which shut down equipment, and the lack of usable qualities of refractories nullified a great deal of the otherwise available excess capacity.

Electrodes for electric steel furnaces likewise declined in quality early in the war, but no serious

[1] At Hirohata, for instance, approximately 1,505,000 kilo-calories were required per ton of ingot steel in May 1944. By March 1945 the figure had risen to 2,671,000 and by August to 3,406,000 kilo-calories.

shortage developed until later. By 1944, inability to get electrodes had drastically curtailed the operation of the electric steel furnaces, and by April 1945 they became virtually impossible to obtain. Thereafter, a number of electric steel plants were completely shut down.

In the later phase of the war, operating problems which previously had arisen only sporadically, began to become more frequent, more severe, and to converge upon the steel mills simultaneously. The cushion of excess capacity in good operating condition was gradually used up in meeting these crises. The solution of one set of problems no longer cleared the road for normal production; instead a vicious circle was usually set into operation. For example, raw materials shortages brought lower ratios of production to capacity for blast furnaces which, in turn, required longer refining periods in the steel furnaces with consequent greater wear on progressively poorer quality refractories. The lower-grade and less uniform steel then imposed unusual strains upon rolling mill equipment already suffering from less accurate bearings and poorer lubricants.

7. *Labor difficulties*

Another problem which the industry faced and which became increasingly acute as the war progressed was an inadequate labor force. This problem existed despite a sharp increase in number of persons on the payrolls of the steel plants, because of the inefficiency of new workers. The following table covers only ordinary rolled steel workers, but it provides a fair index:

TABLE 11.—*Ordinary rolled steel workers, and index of annual output per worker, Japan proper, calendar years 1941–44*

Year	Average number of workers	Index of annual output per worker
1941	125,437	100.0
1942	143,890	86.9
1943	210,402	59.0
1944	193,913	40.9

Source: Iron and Steel Control association (TEKKO TOSEI KAI), reply to USSBS Manpower Division questionnaire, November 1945.

While a lack of labor and the reduced efficiency of the force in the steel plants never prevented the processing of raw materials nationally available, it did cause temporary and local delays and prevented the maximum yield from the limited raw materials, The labor problem was primarily one of lack of skill. not lack of numbers.

Military manpower requirements took large numbers of skilled steel workers in 1941 and 1942 due to a prewar policy of the industry of employing military reservists. For example, by 1942 nearly one-third of skilled workers and foremen had been called to the colors. When in 1943 the workers in the essential industries were put into a semi-military status, and steel industries were allotted commandeered labor, the drafting of essential employees was stopped. But at the Yawata works, for example only 1,000 of 60,000 men were declared essential, and laborers continued to be called up. Plant superintendents reported shortages of skilled labor in 1942 with shortages of coolie labor becoming acute in the spring of 1944.

Adequate replacements for men drafted into the services were not available. Conscription of men from non-essential work from 1943 on provided a portion of replacements. For instance, one-third of the workers in the Kanagawa works of the Sumitomo Special Steel company were of this category in 1944 Koreans, totalling 12,669 throughout the industry on 15 August 1945, provided a considerable—although unwilling—relief to the shortage of coolies. Nearly 4,000 were on the 1944 rolls at the Yawata works for instance, although the average working daily was only 2,000. As one plant manager reported "There was a bad tendency of Korean laborers running away from plant . . . " The number of women replacing men in clerical jobs and in some coolie jobs increased six times in 1941–45, raising the proportion of women in the total labor force to 13 per cent Finally, in the autumn of 1944 student laborers were put into the plants—becoming, by the end of the war, nine per cent of the enrolled labor force. In some areas this proportion was much higher however as in the Tsukiji plant (Nagoya) of Daido Electric Steel company, where in 1945 school boys constituted 44 per cent of employees. One-fifth of all workers in the industry were under 20 years old.

The drop in efficiency of the new laboring force in the steel industry is shown in Table 11. Lack of raw materials to process was an increasingly important reason. Lack of rations and an increase in sickness interfered with individual efficiency. With the beginning of bombing, the disruption of communications and transportation, the burning of workers homes, the interruption of the food supply in the urban areas, the alarms and hours lost in shelters and the attendant social disorganizations, all had a part in the incalculable but drastic decline in efficiency from December 1944 on.

One symptom of the reduction of labor efficiency was the increase in absenteeism. The rate of absen-

teeism in the industry had usually been less than nine per cent in the winter with one per cent increase in the spring and fall. Beginning in 1942 the rate increased at about one per cent a year until 1944, when sharp rises occurred. At the Japan Steel Works at Muroran, far removed from bombing, the rate of 10 per cent in October 1944 rose to 13 per cent in April 1945. In urban areas the rate is closely correlated with the incendiary raids. Japan Steel Tube company in Kawasaki had a rate of 10 per cent in January 1945 jump to 52 per cent during the April raids. Similar examples could be cited in Nagoya, Osaka, Kobe and the other urban areas. Absenteeism at the time of the urban raids was naturally to be expected. The general increase throughout the war, however, has been attributed by the Japanese to a number of causes. One of these was the low rate of pay in steel plants as compared to the general inflation. For example, the highest average wage was that paid to workers over 20 years old which rose from ¥5.03 per day in 1941 to ¥7.50 in 1945, for an average 11.9 hour work day. Wages were supplemented with welfare payments of about 10 per cent and bonuses varying from 20 to 100 per cent; but compared with the black market wages for laborers and the wages paid on military and public projects, up to ¥ 30 a day, the incentive for the laborer to absent himself from the steel job into which he had been frozen was high. Another cause by which absenteeism was explained was the general social unrest due to the tide of war and an attendant "spiritual relaxation."

. *Administrative conflicts*

As the supplies of steel fell below the increasing needs and plans of the nation, the controls over the production and distribution of steel became the object of bitter conflict. Over-all planning, in the Cabinet Planning Board, had been dominated by the Army and Navy. But the actual administration of the plans, under the Ministry of Commerce and Industry and the Iron and Steel Control Association, had been left to the industrialists.

The planning was invariably overly optimistic and when production fell short it was impossible to satisfy all the promises. Hungry for steel, the armed services pressed hard for special considerations through the system. Achieving only a measure of success, they operated outside of the system and with private stocks of raw materials and direct contacts with producers, particularly the producers of special steel.

In November 1943 the conflict was resolved in favor of the military through the formation of the Munitions Ministry, a move long urged by both services. From then on planning and top administration for the entire steel industry was under an Army-Navy dominated, but unified control system, which supplanted both the Planning Board and the Ministry of Commerce and Industry. But the basic problem—not enough steel to go around—remained unsolved; and the military lacked the technical qualifications which were essential to the task.

This increased control over the administrative machinery gave the militarists amounts of steel in excess of their planned shares and the immediate war-making strength of Japan was increased. But the victory was costly—the long-range war potential of the nation was fast deteriorating. And by 1945 frequent and severe breakdowns in the industrial plant caused many crises which had to be met by special allotments and make-shift emergency planning.

9. *Steel consumption pattern during the war*

The peak year for steel distribution within Japan proper was fiscal 1943 when 5,376,000 tons, excluding exports, were accounted for. Thereafter the amount of steel delivered to consumers declined sharply. The rate of decline was less sharp, however, than the drop in the production rate due to the drawing out of a limited stock of finished steel. The following condensed table indicates the extent to which available steel was channeled toward military supplies.

TABLE 12.—*Finished steel distribution, Japan proper, fiscal years, 1942–45*

[In thousands of metric tons]

Category	1942	Per cent	1943	Per cent	1944	Per cent	1945[1]	Per cent
Army ground forces	840	17	1,148	21	598	13	106	15
Navy surface forces	1,120	23	1,238	22	1,059	22	150	20
Merchant ship-building	536	11	920	17	1,324	28	228	31
Air forces (combined)	485	10	559	10	961	20	138	19
All others	1,901	39	1,691	30	817	17	108	15
Total	4,881	100	5,554	100	4,761	100	729	100

[1] First quarter only.

Source: Appendix Table 14.

It may readily be seen that the ground forces received their peak distributions in 1943; thereafter the Army supply was sharply reduced. The Navy consistently received about one-fifth of the national total. The combined air forces received increasing amounts until 1945. Large percentages of their de-

liveries were of special steel—i.e., 146,800 tons or 20 per cent of all special steel in 1943, 536,500 tons or 46 per cent in 1944. The amounts of steel delivered for merchant ship-building indicate the extent of the fruitless effort made to restore tonnages lost via sinkings. Despite allotments that rose to 28 per cent of the whole in 1944, however, a shortage of steel was a major reason for reducing the projected merchant ship-building program that year from 2,550,000 GRT to 1,996,000 GRT, and in 1945 to 517,000 GRT. Shortages of steel throughout the war denied the shipyards sufficient stocks to permit prefabrication. Production was also hampered by aggravated shortages of plate thicker than 10 mm, and by low quality plates which cracked under cold bending, and performed badly in electric welding.

The amounts furnished the military forces were made available only at the expense of all other parts of the economy. Only the light metals and the steel industry itself avoided substantial reduction in 1943. In the case of the latter, it may be attributed to the expansion of facilities for sintering and concentrating the low-grade ores which the industry was being forced to use.

Other industries without steel's high priority were in many cases short even for adequate maintenance. This induced a series of maintenance crises, such as those stated to have occurred in petroleum drilling in the autumn of 1944, in synthetic fuels and coal during the winter of 1944–45, and in nitric acid in February 1945. Those crises were met, if at all, by special allotments of steel from Army and Navy quotas added to the indicated civilian allowances. Finally, a special "machinery emergency" category was placed in the national allocations plan in 1945, providing a pool for repairs of vital machinery and specially allotted by regional offices of the Steel Bureau of the Munitions Ministry as emergencies arose.

Admiral TOYODA, ex-Munitions Minister, stated in an interview that the allocations formula during the late period of the war was "50 per cent Army, 50 per cent Navy".

10. *Production without imports*

The success of the attack on the movement of water-borne raw materials caused ingot steel production to skid to a rate of about 325,000 tons monthly in March 1945. To that decline the air bombing of Japan and the naval bombardment of Wanishi and Kamaishi added an unmeasurable impetus. It is of interest therefore to speculate on the level to which production would have fallen if the home islands had not been subjected to attack and if Japan had been left free to produce what it could with domestic raw materials.

During the war Japan had been able to increase its production of iron ore, iron sands, and pyrite sinters from about 1,500,000 tons in 1941 to 4,400,000 tons in 1944. The quality of ore had deteriorated and was not completely substitutable for the higher grade imported ores. At an average Fe content of 45 per cent, domestic ores would have supported a pig iron production of about 2,000,000 tons annually.

In the last stages of the war, however, general-use coal and coking coal were the real limiting factors rather than ore. The Wanishi plant in Hokkaido was the only self-sufficient plant, using local ore and coal. But even at Wanishi the reduction in efficiency caused by inferior raw materials was responsible for bringing production in the first quarter of 1945 down to 4 per cent of the war time peak quarter.

Electric steel making was falling rapidly owing to the shortage of electrodes, and open-hearth production was declining for the various reasons previously noted. The scrap stockpile had by then largely disappeared, and, with the limitations of transport and handling facilities (and the administrative malfunctioning demonstrated during the last of the war), it is unlikely that the Japanese would have alleviated the shortage by collecting the low-quality scrap created by air raids or by cannibalizing their idle industrial plant. Therefore, all factors considered, it seems unlikely that an annual ingot steel production of more than 1,500,000 tons could have been maintained in the absence of imports of raw materials, even without air attacks. And the quality of the steel output would have been quite unsatisfactory for many purposes.

IV

EFFECTS OF ALLIED ATTACKS

1. *Steel as a direct target*

The steel industry is of special interest in any analysis of the war against Japan because it was selected as the first target system to be attacked when the air war finally advanced to the Japanese homeland, the specific target in the system being the sup-

possibly critical coking plants. Because of the difficulty of supplying the B-29s based in China, it was possible to launch a total of only five comparatively light raids against steel plants from June to September of 1944. The Marianas became available for operations in late 1944. At that time, other industries were made the highest-priority target systems because a re-evaluation of intelligence led to the conclusion that there was a substantial cushion of excess capacity in the steel industry which would have to be destroyed before production would be affected.

From late September 1944 to March of 1945 the steel industry had a breathing spell. But in March the incendiary assault on urban areas began indirectly to affect the steel plants in those areas. Also some plants suffered damage during this period from these fire raids and from the spillage of bombs aimed at nearby targets. The last phase of the attack before the war ended was the heavy naval bombardment of the important steel targets in Northern Honshu and Hokkaido during July and August 1945. These plants were operating at the highest level of capacity in Japan because of the proximity of domestic raw materials.

All of the important steel plants in Japan proper—with the exception of the modern Hirohata plant of the Japan Iron Manufacturing company which was situated far from any urban concentrations—suffered some degree of bomb or shell damage during the war. Out of a total of 327 primary and secondary steel plants, 103 were hit by one or more naval shells, and HEs or IBs dropped by aircraft. However, as far as the steel plants were concerned, none of the air raid attacks were on a large scale. B–29s dropped a total of 160,000 tons of bombs of all kinds throughout the war; only 771 tons were specifically aimed at iron and steel targets—550 tons in Manchukuo and 221 tons in Japan proper. The effect of these various types of attacks can best be demonstrated by a consideration of some of the specific plants which were damaged.

2. *Direct attacks*

a. *The Yawata works.* The first target of the B–29 offensive against Japan was the Yawata works of the Japan Iron Manufacturing company in Northern Kyushu, the largest steel plant in Japan. On the night of 15–16 June 1944, China-based bombers—about 67 planes—carried 95 tons of bombs to be directed against the coke-oven installations from 30,000 feet over the target. Two months later, on 20 August, a second, high-level raid was made by 71 planes with 112 tons of bombs. The latter was a daylight attack.

Only five 500-lb bombs fell within the works on the June night raid and production was not materially affected; the only damage was of a slight nature to one boiler plant. The results of the August daylight raid were much more gratifying. More than 200 bombs, 500-lb size, were counted by the Japanese within the plant limits. Both of the two coke-oven areas were hit, one by 22 bombs, the other by five bombs. Of a total of eight batteries, all in operation, two received direct hits; accessory equipment was also damaged. Pig-iron facilities received 39 hits although the blast furnaces were not directly damaged. Steel-making facilities received 11 hits; the by-product plants 42; and the power plants nine. The remaining bombs sank 23 vessels in the harbor, cut plant rail lines in 101 places, power cables in 18 places and watermains in 36 places.

A majority of the damaged facilities were completely repaired within one week. Except for the coke ovens and some machinery, the rest of the damaged installations were back in operation within a month. Because there was excess coking capacity as a result of coal shortages, the Japanese decided not to rebuild the badly damaged coke battery, but instead ingeniously bricked up the seven destroyed ovens in the center of the affected battery, connected the two ends and successfully operated the undamaged ovens on either side.

Production at the Yawata Works during the period before and after the two raids is shown in Table 13.

TABLE 13.—*Production at Yawata Plant, Japan Iron Manufacturing Company, June–December 1944*

[In thousands of metric tons]

1944	Coke	Pig iron	Open-hearth steel ingot	Electric Furnace steel ingot	Rolled products
Rated capacity monthly	205.9	175.0	207.7	13.7	208.7
April–May average production	160.5	127.8	174.5	17.1	136.6
June	153.2	116.3	148.1	14.3	110.9
July	146.3	107.7	135.2	11.8	94.5
August	103.1	68.9	91.7	10.6	65.2
September	109.9	75.2	96.8	11.7	58.1
October	131.5	96.4	128.3	13.9	92.3
November	130.8	85.9	126.2	16.3	91.5
December	142.2	100.3	132.1	19.0	86.7

Source: Japan Iron Manufacturing company, October 1945.

Production at Yawata was declining before the raids began—a direct reflection of the shortage of imported coal and ore, purchased pig iron and steel ingots and an electric power shortage caused by an unusual dry season. The August raid actually did affect production, but it resulted in a postponement

rather than a permanent loss, for in October, November, and December, through the use of raw materials not consumed in the previous quarter, production exceeded the allotted quotas in almost all departments by an amount greater than the estimated losses during the previous two months. This was possible, of course, because of the existence of unused capacity. December production represented the climax of the recovery, and thereafter there were declines in all products.

b Showa Steel works. The second target to be attacked was the large plant of the Manchukuo Iron Manufacturing company at Anshan, Manchukuo (known until January 1945 as the Showa Steel works). Three raids—on 29 July, 8 September and 26 September 1944—were directed against this plant with the best results achieved by aerial attack on any steel target.

The Anshan plant differed from the Yawata plant as a bombing objective in one important respect. Most of the raw materials required to operate the Anshan Works at capacity were locally available or accessible by rail, and, as was to be expected, at the time of the raid the plant was operating at a high level of capacity with good prospects for continuing to do so; it stood to become increasingly important as a supplier of pig iron to Japan, as production there declined. The plant was second in size only to Yawata; in fiscal 1943 it had produced 22 per cent of the total pig iron turned out in Japan, Manchukuo, Korea and China combined. A detailed assessment of the effect of those raids is presented because bombing accuracy—in the first raid particularly—was good and the plant was an economically vulnerable target.

(1) *First raid.* On 29 July approximately 90 B-29s were sent against Anshan with the coke oven area as the primary target within the large compound. A total of 468 500-lb bombs were dropped over the target area from approximately 30,000 feet. Of that number 237 bombs (51 per cent) fell within the limits of the plant, including 25 duds. The number of persons killed in the raid was 129.

The distribution of the effective bombs was as follows:

	No. of bombs
Coke ovens (primary target), 4 batteries hit	16
By-products plant	28
Coal washing plant	16
Blast furnace plant—3 furnaces hit	32
Transportation facilities	92
Unaccounted for	28
Total	212

The two open-hearth steel works and all of the rolling mills escaped direct hits.

Immediately before the raid, five of the 17 batteries of coke ovens in the plant were either closed down or under repairs; the damage to four batteries thus left eight available for operation. One of the nine blast furnaces had been under repairs before the raid so that five remained available. No evidence could be obtained concerning the immediate effects on the operation of the plant or as to what was done to shut the plant down or minimize damage (no personel who were present at the raid were found in Japan), but available company officials stated that operations were at once curtailed. Damage to 1,060 meters of gas mains, 887 meters of feed-water and drainage pipe and to 4,500 meters of rail lines prevented more than nominal use of the unaffected portions of the plant for several days.

Repair of the damaged installations was promptly started, and some parts of the by-product plant were in condition to operate again within a week. The four coke batteries, however, were out of operation for a minimum of 53 days. One of the damaged blast furnaces was repaired in nine days, another in 11 and the third in 21 days. The two coal washing plants were out until the middle of August.

Monthly data for the principal products, as shown in Table 14, indicate that this raid had a sharp impact on all major departments, falling most heavily on the open-hearth works and least heavily on the coke output.

TABLE 14.—*Index of post-raid production at the Showa Steel works, July 1944-March 1945*

[July pre-raid rate taken as 100]

Month	Coke	Pig iron	Steel ingots	Rolled steel
1944				
July	100.0	100.0	100.0	100.0
August	36.3	34.2	12.2	23.4
September	48.0	33.0	18.2	32.4
October	58.1	58.6	58.0	42.9
November	66.5	73.0	77.8	51.9
December	52.8	53.7	26.7	22.8
1945				
January	57.9	59.0	34.4	92.0
February	52.4	55.9	65.5	94.9
March	93.8	99.1	73.2	98.3

Source: Compiled from data supplied by former officials of Manchukuo Heavy Industrial Development company in Tokyo, November 1945.

The reasons for the disparity between the effects upon the several departments shown in Table 14 could not be specifically accounted for, but it seems likely that the greater reduction in steel ingot output was the result of the interruption of gas supplies and the reduced amount of gas available until the coke batteries were repaired. Coke-oven damage also can

be credited with reducing the rate of production in the blast furnaces.

(2) *Second raid.* A heavier high-level raid was staged on 8 September. Some 216 tons of bombs were dropped; 605 hits were counted by the Japanese, of which 298 bombs (49 per cent) fell within the plant limits, although only 252 bombs (41 per cent) detonated. The pattern of hits was as follows:

	No. of bombs
Coke ovens (primary target) 9 batteries hit	71
By-products plant	50
Coal washing plant	8
Blast furnace plant	4
Rolling mills	15
Transportation facilities	72
Unaccounted for	32
Total	252

Of the nine coke batteries hit only four were in operation at the time of the raid. It is evident from Table 14 that the damage in this raid was minor compared with the first raid. Coke production in September improved substantially over August and continued to improve until December. All of the damaged batteries were restored by 29 September (including those hit earlier) and some as soon as 14 September.

Pig iron production, however, unlike coke, did not recover during September, but instead fell slightly further that month. The reason for that seems to lie not in the minor damage done to the furnace area, but in the fact that during and immediately after the raid the furnaces were all taken off blast and could not be started up again for varying periods owing to damage to water mains (1,870 meters), gas mains (2,320 meters), railroads (4,000 meters) and some of the blowing engines, boilers, and electrical equipment. Only one furnace could resume production at once, and the others were out for 6 to 25 days.

Both of the coal washing plants were hit again, but were repaired by the 12th and 26th of the month. The by-products plant suffered more seriously, with some units out until 15 October. In addition, the large bar mill was hit, but repaired by 15 September, and the No. 2 blooming mill was knocked out until 10 October. Both crude steel and rolled steel production improved somewhat during September.

(3) *Third raid.* A third raid by the same Air Force was staged on 26 September, in which 217 tons of bombs were dropped over the target area. Accuracy in this occasion was very poor, for the company reported that only 29 bombs fell within its premises, of which five failed to detonate. No damage of consequence was done. As may be seen in Table 16, the third raid did not interrupt the recovery of production in any of the major departments.

(4) *Losses of production.* Table 14 shows that the recovery in production which commenced in September continued through November, but that in the following three months it fell off badly again in all categories except rolled steel, and even that dropped sharply in December. The reasons attributed by company officials for this development were (a) a heavy increase after 1943 in the use of North China coking coals and reliance upon rail transport for its delivery, (b) serious disruption of the North China rail lines' capacity in late 1944 as a result of Allied (14th AF) air attacks, sabotage and an unusually severe winter, and (c) the exhaustion of coal reserves at Anshan which reduced supplies on hand at one point to less than 5,000 tons. As a result of lack of coal, coking operations had to be curtailed with consequent effects on the other departments. When coal could be obtained again, almost the full pre-raid rate of production was reached in all categories except crude steel.

The total actual loss of production attributable to the three air raids cannot be precisely determined because of the intervention of the foregoing factors. However, the loss of production through November was in all probability caused very largely, if not entirely, by the damage done in the air strikes. Those losses may be computed as follows:

TABLE 15.—*Production losses due to air raids at Showa Steel works*

[In thousands of metric tons]

	Coke	Pig iron	Steel ingots	Rolled steel
Actual output, 1 April–29 July	533	418	261	189
Assumed output 30 July–30 November at average daily rate of July pre-raid	498	388	233	149
Actual output, 30 July–30 November	266	193	97	56
Production loss	232	195	136	93
Per cent loss to assumed output	46.5	50.2	58.3	62.4

Source: Compiled from data supplied by former officials of Manchukuo Heavy Industrial Development company in Tokyo, November 1945.

3. *Urban area raids*

The effect of the bombing of urban area concentrations was limited by the geographical distribution of the iron and steel industry within Japan. Because of the requirements of space and transportation, at least 80 per cent of the total coke and pig iron capacity was located outside of the areas attacked by fire bombs. On the other hand only 45 per cent of open-hearth furnace, 11 per cent of electric furnace, and 41 per cent of steel rolling capacity was not located in urban concentrations. The timing of the raids also

limited their effect on the steel industry. A very few attacks had touched the steel industry before March 1945, and thereafter, when the weight of the attack became substantial, declining production as a result of the attack on shipping had already resulted in idle capacity throughout the entire industry.

An example of the more successful results of fire raids is the case of the Tsukiji plant of the Daido Steel company, located in Nagoya. It was directly damaged by three attacks delivered against that area. On 18 December 1944, 170 IBs and four 250-lb HEs burned or destroyed one of three melting shops, wooden storehouses and offices aggregating 20,120 square feet. One of the plant's ten electric furnaces was ruined. On 17 March 1945, 12 IBs burned out 3,100 square feet of wooden store houses. On 17 May the most serious incident occurred, when about 1,480 IBs destroyed buildings totalling 418,281 square feet of floorspace, including two melting shops, four heat treating shops, two forging shops, three machine shops, the boiler room and repair shop. After the last raid, the melting shops were repaired and operable by 21 June, and one machine shop and two heat treating shops were operable by 16 July. The rest of the damage was unrepaired at the end of the war.

Production was declining at the Tsukiji plant throughout the period of the fire raids because of a number of external factors. Therefore, it is difficult to isolate the production loss resulting from the air raids. Receipts of water-borne raw materials were rapidly decreasing; 28 forging hammers and presses had been removed to be installed elsewhere; an earthquake on 7 December 1944 had destroyed 30 per cent of the boiler capacity and caused breaks in the water mains that hampered operations for the rest of the war. Frequent changes in specifications for finished products by the military had also reduced efficiency. As this particular Daido plant was producing special steel to be used in aircraft and in other critical military equipment, it is not surprising that in November 1944, before the first attack, it was operating at about 90 per cent of existing capacity. The decline in the planned production and in actual production of ingot steel is shown in Table 15. The Japanese attributed the failure to meet production schedules in largest part to the direct effect of air-raid alarms and damage. The lowering of planned production, which dropped 53 per cent from November 1944 to April 1945, is principally explained by the factors other than bombing enumerated above.

The unspecified "other" in Table 16 is largely a reflection of increased labor absenteeism, which skyrocketed from four per cent in November to almost 18 per cent in March and reached a peak of 19 per cent in July 1945. A large number of man-hours was also consumed in 1944 and 1945 in repairing damaged facilities.

TABLE 16.—*Production lost due to air raids and other causes, Tsukiji plant, Daido Steel company, Nov. 1944-Aug. 1945*

[In metric tons]

Month	Planned production	Actual production	Loss attributed to:		
			Alarms	Damage	Other
1944					
November	4,200	3,476	420		304
December (raid)	4,200	2,157	840	1,203	
1945					
January	3,000	1,110	900	990	
February	3,000	1,220	900	880	
March (raid)	3,000	1,665	1,200	144	
April	2,000	917	600		483
May (raid)	2,000	930	800		270
June	2,000	730	800	200	270
July	2,000	441	1,200		359
August	2,000	438	800		762
Total	27,400	13,084	8,460	3,417	2,448

Source: Daido Steel company, October 1945.

4. *Spillage damage*

Another source of bomb damage was so-called spillage from attacks on targets near steel plants. An example of heavy damage occuring in this way was the destruction in the plant of the Japan Steel Tube company at Kawasaki. During July and August 1945 the Kawasaki works was hit four times in raids aimed at nearby oil targets.

On 13 July 46 HEs (500-lb) struck the plant. That was followed by about 100 bombs during the night of 25 July, 342 bombs on 1 August, and some strafing and nine more bombs on 13 August. Serious damage resulted to the coke ovens, the by-products plant and the blast furnace hot-stoves, and lesser damage to the steel-making plant. However, in June, the month before the first raid, this important plant—second largest in Japan—was operating at only 17 per cent of its coke capacity and 5 per cent of its pig-iron ingot steel and rolled products capacities owing to the universal shortage throughout the industry of raw materials. Seven days before the first raid the iron plant closed down. Therefore, although by inspection the plant might well qualify as the most heavily damaged steel plant, the effect of the damage on production again was slight.

A second example of spillage damage is the Amagasaki plant of Amagasaki Iron and Steel Manufacturing company which was severely hit in raids in mid-1945 directed against a nearby oil refinery. Damage to coking and pig iron installations was estimated

at 70 per cent, but no effect upon production was achieved inasmuch as these departments had been shut down for want of materials since August 1944.

5. *Naval bombardment attacks*

The notable exceptions in 1945 to the raw materials starvation in steel plants were the Kamaishi and Wanishi plants of the Japan Iron Manufacturing company. Because of their location in northern Honshu and in Hokkaido, they were both close to the best iron ore and coking coal deposits which Japan proper possessed and more accessible to those North China and Manchukuo raw materials which could be shipped across the relatively safe Japan Sea from north eastern Korean ports.

The Kamaishi plant was located near the Kamaishi iron ore mines. Therefore, only coal had to be brought in by water. As a government policy, shipments of Mishan coking coal from Manchukuo and from North China to Kamaishi were maintained—but at a declining rate—until almost the end of the war, and mixed with nearby Hokkaido coal. As a result, production of coke, pig iron, ingot steel and rolled products was at a higher ratio to capacity than in the industry in general.

The Wanishi plant, as part of the Hokkaido self-sufficiency program, had been thrown entirely upon the coking coal and ore mined on that island. The local coal was the best available coking coal in Japan, but still much inferior to imported coking coal. Although both iron ore and coal were available in adequate quantities for near-capacity operation, the reduction in quality of the coal and its effect on the coke ovens had greatly reduced the efficiency of operation and caused a drop in both the quality and the quantity of coke production. However, the Wanishi plant was fairly important in the last stages of the war because, although production in the rest of the country was dropping precipitously, the chances were that the level of production at Wanishi could have been maintained. Production at the two northern plants compared with the national average in June 1945, the month before the naval bombardment attacks, as shown in Table 17.

TABLE 17.—*Ratio of production to capacity at the Kamaishi and Wanishi plants of Japan Iron Manufacturing company compared to the national average, June 1945.*

[Expressed as percentage of capacity]

	Coke	Pig iron	Open-hearth ingots	Rolled steel
National average	27	32	17	19
Kamaishi plant	56	38	42	53
Wanishi plant	33	31	10	20

Source: Appendix Tables 10 and 29 and Japan Iron Manufacturing company, October 1945.

The two plants accounted for 40 per cent of the remaining pig-iron production in Japan proper during the first quarter of fiscal 1945. These plants and the Japan steel works at Muroran, Hokkaido, a producer of steel and an important armament plant, were the objectives of four naval bombardments in July and August 1945. Details of those attacks and the damage caused will be found in the Report of the Ships Bombardment Survey Party.

The Wanishi plant was attacked once—on 15 July 1945. Task Group 34.8 directed 432 16-inch HC shells in addition to some smaller caliber shells against the plant. The Japanese counted 171 hits within the works. The bombardment caused considerable direct damage to one of the blast furnaces, to three of the open-hearth furnaces and to the blooming and rod mills. But this damage was less significant than the indirect damage to the coke batteries. All three of the batteries in the old section of the plant cooled rapidly when water and power services were cut by the bombardment, with consequent shrinkage and opening of leaks which completely ruined two batteries and reduced the efficiency of the third by about 30 per cent. The three newer, larger, and less brittle batteries could be more carefully handled and cooled less rapidly. The loss of production in those batteries did not exceed one month's production. If the war had continued, the total coke production loss for the entire plant would have been equal to at least two and one-half month's production (spread over a period of about one year) and probably would have been higher. The effect of the bombardment upon pig iron production would have been slightly less than that because of small supplies of coke received from other sources not affected by the bombardment.

The bombardment of the Muroran plant took place the same day. Some 434 16-inch HC shells plus additional eight-inch and smaller caliber shells were directed against the plant. This bombardment caused some damage to the section of the plant producing finished and semi-finished armaments. The steel-making section, however, completely escaped serious direct damage. Effects on labor absenteeism and morale are estimated to have caused a steel production loss equal to 30 per cent of the month's production.

The Kamaishi plant on Honshu was twice the target of naval bombardment. On 14 July 1945, a total of 802 16-inch HC and some smaller caliber shells were used. On 9 August 686 16-inch HC shells and 117 16-inch AP shells were thrown at it in addition to the smaller calibers. In the first bombardment

all four of the coke batteries at the plant were incapacitated, at least temporarily, through damage to accessories. The total production loss which would have resulted from this attack is estimated to be equal to about two and one-half months' production at the pre-attack rate. Damage to other parts of the plant in that attack was less significant.

The bombardment on 9 August was much more effective than the first and caused heavy damage throughout the plant. In that attack all three of the plant's blast furnaces received heavy damage; production in those furnaces was expected to be negligible during the six months following. Recovery plans contemplated repair of damage to two of the three furnaces within six to eight months; thereafter coking capacity was expected to be the limiting factor on production. Of the four coke-oven batteries, the least injured one was repaired before September. More serious damage to two other batteries was expected to be repaired within seven to nine months. However, rapid cooling after the attack of the fourth battery, with consequent serious shrinkage, caused leaks which destroyed its usefulness; repair was considered impossible, and the minimum replacement time was estimated at 18 months by company engineers.

The total pig-iron production loss resulting from the two bombardments of Kamaishi would have been equal to at least eight, and probably ten months production at the pre-attack rate if the war had continued.

6. *Recapitulation of aerial and naval attacks*

As the only direct air attacks against the steel industry occurred before experience with the operational problems of the B-29 had been gained and at a time when tactics called for bombing from 30,000 feet or more—as compared to the later 15,000 feet or less—too much could not be expected in the way of concrete results. Nevertheless, the attack against the Showa works in Manchukuo demonstrated that direct hits with HE bombs can cripple a steel plant and under certain conditions seriously curtail production.

The strategic bombing of the steel industry in Japan proper was relatively insignificant in its effects on the industry as compared to the effects achieved by the attack against shipping. Deprivation of good-quality raw materials had by December 1944—when a full-scale air attack could for the first time have been mounted against the industry—reduced ingot-steel production to 43 per cent of rated capacity. The effect had been to create a cushion of capacity which Allied attack must destroy before it could more than delay production by requiring its reorientation. A comparison of 1944 rated capacity in iron and steel plants located in Japan proper with capacity at the war's end shows that the total loss in capacity due to all factors, including (a) bombing and naval gunfire, (b) lower labor and raw material efficiency, and (c) voluntary dismantling, was relatively slight.

TABLE 18.—*Annual rated capacity, before and after attack, Japan proper*

[In thousands of metric tons]

	April 1944	September 1945	Difference
Ingot steel	13,644	11,696	1,948
Finished steel	10,388	9,799	589

Source: Appendix Table 10 and Iron and Steel Control association (Tekko Tosei Kai), October 1945.

A comparison of the national rate of production with the pattern of ingot steel production in all plants hit shows that during the months of concentrated air and surface attack, production did not decline any faster in those plants.

TABLE 19.—*Index of ingot steel production in all plants and in attacked plants, Japan proper, October 1944-June 1945*

[October–November–December 1944 production taken as 100]

	Attacked plants	All plants
October–November–December 1944	100	100
January–February–March 1945	75	71
April–May–June 1945	55	54

The effect of the attacks on production, then, was not substantial and was limited to those few plants which were operating at a fairly high level when hit.

If the war had continued beyond August 1945, the dividends from the naval bombardment would have been substantial. As previously indicated, in the first quarter of 1945, about 40 per cent of the remaining pig-iron production was concentrated in the Kamaishi and Wanishi plants whose relative importance stood to increase as production continued to decline in the rest of the industry.

V

VULNERABILITY OF STEEL INDUSTRY TO AIR ATTACK

It is self-evident that the machinery and equipment used in iron and steel manufacturing is little susceptible to physical damage from bombs, except of the heaviest types. The major units are massive and built to withstand great strains; fires and explosions are normal operational hazards and equipment and trained personnel are usually available to combat such emergencies. There are, nevertheless, many vital points in a steel plant which can be severely damaged by direct hits. The coke ovens, the aiming point for the first air raids on Japan, are among the more vulnerable installations. These are constructed with fragile refractory silica bricks which must be precisely fitted together to make the ovens air and gas-tight. A direct HE hit will destroy a substantial number of the ovens in a coke battery and may render a number of adjacent ovens inoperable by misaligning the oven walls. Further damage may also be caused by uncontrolled or rapid cooling of intact ovens—as was seen at the old section of the works at Wanishi and Kawasaki Works of Japan Steel Tube company. However, direct hits on operating ovens do not necessarily require the rebuilding of a battery when rapid cooling is prevented—as was demonstrated at Yawata.

Damage to plant transportation systems—gas and water mains, steam and air pipes, rail lines, cranes and conveyors, which are all highly susceptible to attack—is surprisingly effective in closing steel plants for short periods and compares favorably with damage to the productive facilities.

The time required for recuperating from bomb damage depends in largest part on the availability of repair parts and stand-by equipment. Contrary to the situation in Germany, in the case of the Japanese industry there was a serious shortage of necessary spares. And although the Japanese did not try to bring many of the damaged installations back into production because of the existence of adequate idle facilities elsewhere for using the limited raw materials, undoubtedly the lack of spare parts would have prevented rapid recovery. The necessity for cannibalizing installed equipment to meet scheduled new construction on the mainland and elsewhere in Japan, of which there were many instances, testifies to the dearth of extra equipment and machinery.

On-the-spot study of damage from IB at steel plants indicated that this type of attack is relatively ineffectual with respect to productive facilities as compared with HE attacks. Only electric furnaces with their dependence upon transformer stations and electric cables and wiring showed any considerable susceptibility to incendiary attack. In Japan the unusual shortage of stocks from which to replace burned transformers prolonged the effects of such attacks. Further, in a number of plants a high incidence of unpredictable dividends from fire bombs was noted. In one case, the Tobata works of the Japan Iron Manufacturing company, an entire hot and cold, continuous strip-mill installation was put out of action for several months by the effects of two incendiary hits on the electrical control panels of the main motors. The plant was from two to three miles away from the target on that occasion, the urban area of Yawata.

One factor concerning economic vulnerability which is pointed up by an inspection of the Japanese industry is that the difference between rated capacity and production is not an accurate measure of the cushion of capacity. Many Japanese facilities were idle before the 1945 attacks began, but not so many as would be indicated by the low rate of production. For the poor raw materials then available had so reduced processing efficiency as to require the full use of a piece of equipment to turn out less production than its rated capacity.

VI

CONCLUSIONS

1. *Significance and characteristics of the steel industry*

It is axiomatic that a nation without an assured and abundant source of iron and steel cannot wage modern warfare against a strong adversary for any length of time. Yet Japan attempted just that, for despite a rapid, and successfully carried out, expansion of her steel industry in 1937–41, Japan approached Pearl Harbor with a capacity to produce crude steel of less than one-eighth the capacity of her opponents. Moreover, Japan's steel industry had a significant economic vulnerability that nullified the

increases in capacity—the unavoidable reliance on water-borne transportation for the quantities of coking coal, iron ores, pig iron, and alloying metals required for the production of steel at home.

The Japanese planners had hoped, of course, to overcome the serious raw material deficiency by using the resources of Korea, Manchukuo and China which could only be fully exploited if the sea lanes to the continent were secure. Failing in that respect, the disparity between capacity and production could only grow worse and worse; Japan's steel industry could be—and was—starved to death.

2. *Strategy of the attack*

The steel industry received the brunt of three different kinds of attack and minor effects from a fourth. The first, and most important, was the attack on the flow of raw materials to Japan proper which began with the prewar embargoes. The submarine, plane, surface ship and—finally—mining warfare against shipping, by which the blockade screws were applied during the war, continued the assault against raw materials imports. By early 1945, complete success was assured as far as the steel industry was concerned, as all imports except food and salt had been completely stopped.

The second form of attack began in June 1944 with the small-scale bombing raids by B-29s on the two largest Japanese steel plants. The direct attacks terminated in September. It had become evident that the success of the attack on raw materials was creating a rising cushion of excess capacity in Japan proper which would have had to be destroyed in order further to reduce production.

The third attack, the fire raids, was not directed against any specific steel targets, but steel production was somewhat affected. A number of the smaller, though important, plants were located in the industrial concentration targets and hits upon these plants, as well as the general effects upon employees, caused production delays and drops in efficiency. But the meagerness of the supply of raw materials by early 1945—when the fire raids became severe—had shut down many of those plants and greatly curtailed the operations of others.

The last blow—and the coup de grace for the industry—was the naval bombardment of the Kamaishi plant in Northern Honshu and the Wanishi plant in Hokkaido. With raw material imports completely shut off, these two plants had been able to operate at a higher level than the rest of the industry because of their proximity to domestic iron ore and coking coal deposits.

3. *Success of the attack*

A drop from a peak production in Japan proper of 7,800,000 tons of ingot steel in 1943 to an estimated rate of less than 1,500,000 tons annually at the time of the surrender signifies the phenomenal success of the over-all attack. Through military conquests the Japanese had brought essential raw materials under their direct control, but their struggles to safeguard the movement of these materials over the water lanes had been in vain. Even before the attack was greatly intensified, however, their best efforts never resulted in an annual output of more than 10 percent of the top wartime production of the United States.

Although steel as a basic material is usually deep in the industrial economy, in Japan stockpiles were small and pipelines were never filled up, so that the sharp declines in steel output were reflected in end-product output without much time lag. In the last stages of the war, the declines in both the quantity and the quality of production made steel the major limiting factor with respect to most of the tools of war.

Until almost the end, the flow of pig iron from the mainland was important. If air raids against the blast-furnace plants in Manchukuo and Korea could have been continued in 1944, those imports would almost certainly have been greatly reduced, and steel production in Japan proper would have been chopped down even more rapidly than actually occurred.

APPENDIX TABLE 1.—*Coking-coal imports to Japan proper, by source, fiscal years 1940–45*

[Expressed as percentage of total imports]

Year	Period	North China	Manchukuo	Karafuto	Total	
					Amount[1]	Percent
1940	First half	72	2	26	1,842	100
	Second half	91	1	8	1,473	100
	Total	80	2	18	3,315	100
1941	First half	98	1	1	1,654	100
	Second half	95		5	1,763	100
	Total	96	1	3	3,417	100
1942	First half	82		18	2,058	100
	Second half	93		7	1,967	100
	Total	87		13	4,025	100
1943	First half	81		19	1,810	100
	Second half	89		11	1,129	100
	Total	84		16	2,939	100
1944	First quarter	90		10	497	100
	Second quarter	70	5	25	420	100
	Third quarter	88	12		317	100
	Fourth quarter	69	31		201	100
	Total	81	9	10	1,435	100
1945	First quarter	68	32		116	100

[1] In thousands of metric tons.

Source: Compiled from data supplied by Japan Iron & Steel Control association (TEKKO TOSEI KAI), November 1945.

APPENDIX TABLE 2.—*Iron-ore imports to Japan proper, by source, fiscal years 1931–45*

[Expressed as percentage of total imports]

Year and Quarter	Korea		Manchukuo		China[1]		Philippines		Malaya		Other		Total	
	Percent	% Fe	Percent	% Fe	Percent	% Fe	Percent	% Fe	Percent	% Fe	Percent	% Fe	Amount[2]	Percent
1931	10	na			35	na			53	na	2	na	1,727	100
1932	9	na			34	na			54	na	3	na	1,634	100
1933	14	na			32	na			52	na	2	na	1,779	100
1934	8	na			36	na			38	na	18	na	2,312	100
1935	7	50			35	60	8	na	40	63	10	57	3,646	100
1936	6	50			31	60	14	na	42	63	7	57	4,023	100
1937	7	50			14	60	13	na	38	63	28	57	4,313	100
1938	11	50			5	60			50	63	34	57	3,212	100
1939	8	50			14	60	13	na	39	63	26	57	4,949	100
1940	8	50	1	60	20	60	21	na	36	63	14	57	5,719	100
1941:														
I	9	50	1	60	30	61	16	na	40	63	4	59	1,707	100
II	15	50	1	60	50	61	9	na	23	63	2	59	1,536	100
III	20	50	1	60	67	61	3	na	8	63	1	59	935	100
IV	21	50	1	60	68	61	3	na	6	63	1	59	880	100
Total	15	50	1	60	50	61	9	na	23	63	2	59	5,058	100
1942:														
I	15	51	4	60	79	61			2	63			1,054	100
II	16	51	1	60	79	61			2	63	2	59	1,250	100
III	18	51			77	61	1	60	2	63	2	59	1,356	100
IV	6	51			91	61	1	60	1	63	1	59	1,220	100
Total	13	51	1	60	82	61	1	60	2	63	1	59	4,880	100
1943:														
I	5	51			89	59	4	60	2	63			1,268	100
II	4	51			91	59	3	60	2	63			940	100
III	10	51			89	59	1	60					736	100
IV	12	51			82	59	6	60					742	100
Total	7	51			88	59	4	60	1	63			3,686	100
1944:														
I	29	54			71	58							692	100
II	35	54			62	58	3	60					458	100
III	45	54			55	58							312	100
IV	55	54	4	59	41	58							206	100
Total	37	54	1	59	61	58	1	60					1,668	100
1945:														
I	87	54	3	na	10	na							143	100

na Indicates data not available. [1] Includes Hainan Island. [2] In thousands of metric tons.

Source: Compiled from data supplied by Japan Iron & Steel Control association (TEKKO TOSEI KAI), November 1945.

APPENDIX TABLE 3.—*Iron-ore production by mine, Japan proper, Korea, Manchukuo, and China, fiscal years 1931–45*

[In thousands of metric tons]

Company	Location	Mine	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	% Fe before 1941	1941	% Fe	1942 (by quarter) I	1942 (by quarter) II	1942 (by quarter) III
Japan proper																		
Nitetsu Mining Co.	Hokkaido	Kuchyan	91	52	83	111	147	196	213	224	261	325	48	404	47	135	214	13
	Hokkaido	Tokushunbetsu											na	25	50	22	35	2
	Hokkaido	Kamikunobetsu									18	48	52	16	52	23	47	1
	Hokkaido	Others	13	35	24	54	39	39	26	16	26	35	47	67	46	20	25	2
Total			104	87	107	165	186	235	239	240	305	408		512		200	321	18
Nitetsu Mining Co.	Honshu	Kamaishi	104	140	213	267	324	370	320	376	431	415	51	504	50	131	202	19
	Honshu	Akatani										8	50	10	50	18	35	2
Kokan Mining Co.	Honshu	Gunsana											na		na			
	Honshu	Suwa								48	34	50	45	64	43	17	22	2
Matsuo Mining Co.	Honshu	Matsuo											na		na			
	Honshu	Others					6	14	25	102	80	112	48	244	47	63	129	7
Total			104	140	213	267	330	384	345	526	545	585		822		229	388	31
Mitsui Mining Co.	Kyushu	Aso											na		na			
	Kyushu	Others											na		na			
Total																		
Aki Mining Co.	Shikoku	Aki											na		na			
	Shikoku	Others											na		na			
Total																		
Grand Total			208	227	320	432	516	619	584	766	850	993		1,334		429	709	49
Korea																		
Mozan Iron Co.[1]	Korea	Mozan								1	3	255	58	453	58	178	266	27
Rigen Iron Mining Co.	Korea	Rigen	130	150	210	250	240	234	250	262	367	273	46	254	46	53	63	6
Nitetsu Mining Co.	Korea	Kaisen	95	11	103	78	89	76	98	130	150	154	46	259	46	85	69	6
Mitsubishi Mining Co.	Korea	Kasei	132	108	119	121	117	126	154	164	164	181	50	228	50	84	64	7
Others	Korea		60	47	91	121	152	190	203	214	337	209	52	497	51	77	120	13
Total			417	316	523	570	598	626	705	771	1,021	1,072		1,691		477	582	60
Manchukuo																		
Manchukuo Iron Mfg. Co.	Anshan Dist. (High grade)		na	na	na	na	na	na	na	na	na	846	na	1,061	na	na	na	n
Manchukuo Iron Mfg. Co.	Penhsihu Dist. (High grade)		na	na	na	na	na	oa	na	na	na	402	na	395	na	na	na	n
Manchukuo Iron Mfg. Co.	Tungpientao Dist. (High grade)		na	na	na	na	na	oa	na	na	na	268	na	324	na	na	na	n
Manchukuo Iron Mfg. Co.	Anshan Dist. (Low grade)		na	na	na	na	na	na	na	na	na	1,797	na	2,188	na	na	na	n
Manchukuo Iron Mfg. Co.	Penhsihu Dist. (Low grade)		na	na	na	na	na	na	na	na	na	75	na	268	na	na	na	n
Total			na	na	na	na	na	na	na	oa	na	3,388		4,236		na	na	n
China																		
Lungyen Iron Ore Co.	Inner Mongolia	Lungyen	na	na	na	na	na	na	na	na	337	302	na	605	na	na	na	n
Nitetsu Mining Co.	N. China	Wuan	na	na	na	na	na	na	na	na			na		na			
Nitetsu Mining Co.	N. China	Hopei (Prov.)	na	na	na	na	na	na	na	na			na		na			
Japan Steel Tube Co.	N. China	Likuo	na	na	na	na	na	na	na	na		40	na	72	na	na	na	n
Shansi Mining Co.	N. China	Shansi (Prov.)	na	na	na	na	na	na	na	na	na	63	na	67	na	na	na	n
Japan Steel Tube Co.	N. China	Chinlingchen	na	na	na	na	na	na	na	na			na		na	na	na	n
Nitetsu Tayeh Mining Co.	C. China	Tayeh	na	na	na	na	na	na	na	na	77	400	na	1,101	na	261	331	50
Central China Mining Co.	C. China	Maanshan	na	na	na	na	na	na	na	na	430	753	na	1,473	na	na	na	n
Ishihara Industry Co.	Hainan Is.	Yulinkan	na	na	na	na	na	na	oa	na	na	170	na	356	na	na	na	n
Japan Nitrogen Co.	Hainan Is.-	Shiluling	oa	na	na	na	na	na	na	na	oa		na	5	na	10	10	31
Total			na	na	na	na	na	na	na	na	(844)	1,728		3,044		(271)	(341)	(537)
Grand total			(625)	(543)	(843)	(1,002)	(1,114)	(1,245)	(1,289)	(1,537)	(2,715)	7,181		10,305		(1,177)	(1,632)	(1,638)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Production and Fe content figures are for concentrates, not ore.
[2] The Fe content of the Manchukuo mines is based on the estimated Fe content of the reserves, and hence does not apply to 1944 specifically.
[3] Estimated.

Source: Japan proper figures compiled from data supplied by Japan Iron & Steel Control association (TEKKO TOSEI KAI); Manchukuo figures compiled from data supplied by former officials of Manchurian Industrial Development company in Tokyo; and China figures from data supplied by the Japan Iron Mfg. Co., November 1945.

PPENDIX TABLE 3.—*Iron-ore production by mine, Japan proper, Korea, Manchukuo, and China, fiscal years 1931–45*—Continued

[In thousands of metric tons]

Company	Location	Mine	1942 (by quarter)			1943 (by quarter)						1944 (by quarter)						1945
			IV	Total	% Fe	I	II	III	IV	Total	% Fe	I	II	III	IV	Total	% Fe[2]	I
Japan proper																		
itetsu Mining Co.	Hokkaido	Kuchyan	96	575	46	165	210	146	75	596	46	150	183	147	158	638	46	90
	Hokkaido	Tokushunbetsu	34	114	49	46	19	51	51	167	48	56	85	53	76	270	48	42
	Hokkaido	Kamikimobetsu	...	80	52	...	...	...	...	...	na	6	29	22	19	76	51	21
	Hokkaido	Others	12	77	46	21	25	20	20	86	46	26	30	28	22	106	45	20
Total			142	846		232	254	217	146	849		238	327	250	275	1,090	...	173
itetsu Mining Co.	Honshu	Kamaishi	204	734	49	236	286	303	321	1,146	49	275	313	261	291	1,140	49	279
	Honshu	Akatani	...	77	50	24	43	27	11	105	50	34	43	27	7	111	47	21
okan Mining Co.	Honshu	Gunama	...	...	na	...	...	...	...	...	na	10	94	117	46	267	48	39
	Honshu	Suwa	18	77	42	33	55	43	43	174	41	51	60	57	55	223	40	38
Matsuo Mining Co.	Honshu	Matsuo	...	...	na	...	...	...	...	...	na	27	73	24	17	141	50	8
	Honshu	Others	60	325	45	59	185	69	88	401	45	110	202	128	96	136	42	99
Total			282	1,213	...	352	569	442	463	1,826		507	785	614	512	2,018	...	494
litsui Mining Co.	Kyushu	Aso	...	...	na	2	3	4	3	12	42	5	8	14	24	51	40	29
	Kyushu	Others	...	...	na	1	1	2	2	6	40	2	3	4	4	13	40	3
Total			...	...	...	3	4	6	5	18	...	7	11	18	28	64	...	32
ki Mining Co.	Shikoku	Aki	...	...	na	3	3	3	3	12	41	3	4	3	1	11	41	...
	Shikoku	Others	...	...	na	...	1	1	1	3	41	1	1	1	1	4	40	2
Total			...	...	...	3	4	4	4	15	...	4	5	4	2	15	...	2
Grand Total			424	2,059	...	590	831	669	618	2,708	...	756	1,128	886	817	3,187	...	701
Korea																		
Mozan Iron Co.[1]	Korea	Mozan	284	1,001	58	187	218	243	221	869	56	187	351	341	221	1,100	54	137
igen Iron Mining Co.	Korea	Rigen	58	234	46	85	43	43	78	249	46	85	63	86	80	314	46	55
itetsu Mining Co.	Korea	Kaisen	90	306	46	159	68	77	101	405	46	159	117	150	117	543	45	89
itsubishi Mining Co.	Korea	Kasei	88	314	50	63	61	75	81	280	50	67	150	137	149	503	46	116
thers	Korea		95	423	50	119	78	145	214	556	50	120	210	282	315	927	50	284
Total			615	2,278	...	613	468	583	695	2,359	...	618	891	996	882	3,387	...	681
Manchukuo																		
Manchukuo Iron Mfg. Co.	Anshan Dist. (High grade)		na	1,100	na	na	na	na	na	1,236	na	na	na	na	na	1,122	57	na
Manchukuo Iron Mfg. Co.	Penhsihu Dist. (High grade)		na	489	na	na	na	na	na	494	na	na	na	na	na	552	60	na
Manchukuo Iron Mfg. Co.	Tungpientao Dist. (High grade)		na	622	na	na	na	na	na	850	na	na	na	na	na	742	52	na
Manchukuo Iron Mfg. Co.	Anshan Dist. (Low grade)		na	2,130	na	na	na	na	na	2,184	na	na	na	na	na	1,006	30	na
Manchukuo Iron Mfg. Co.	Penhsihu Dist. (Low grade)		na	335	na	na	na	na	na	633	na	na	na	na	na	512	34	na
Total			na	4,676	...	na	na	na	na	5,397	...	na	na	na	na	3,934	...	na
China																		
ungyen Iron Ore Co.	Inner Mongolia	Lungyen	na	923	49	na	na	na	na	855	na	na	na	na	na	[3] 700	na	na
itetsu Mining Co.	N. China	Wuan	...	...	na	...	...	...	9	9	na	8	11	42	32	93	na	na
itetsu Mining Co.	N. China	Hopei (Prov.)	...	...	na	na	na	na	na	45	na	na	na	na	na	66	na	36
pan Steel Tube Co.	N. China	Liku	na	86	na	17	4	45	71	137	na	31	7	57	55	150	na	na
hansi Mining Co.	N. China	Shansi (Prov.)	na	54	na	na	na	na	na	57	na	29	23	19	14	85	na	na
pan Steel Tube Co.	N. China	Chiulingchen	na	33	na	63	53	52	82	250	na	37	27	47	35	146	na	33
itetsu Tayeh Mining Co.	C. China	Tayeh	357	1,455	57	260	274	250	320	1,104	na	264	281	275	63	883	na	na
entral China Mining Co.	C. China	Maanshan	na	1,480	na	302	213	288	385	1,188	na	300	194	...	...	494	na	...
hihara Industry Co.	Hainan Is.	Yulinkan	na	893	60	235	242	263	179	919	na	na	na	na	na	360	na	na
pan Nitrogen Co.	Hainan Is.	Shiluling	46	97	60	47	82	160	105	394	na	76	105	152	27	360	na	...
Total			(403)	5,021	...	(924)	(868)	(1,058)	(1,151)	4,958	...	(745)	(648)	(592)	(226)	3,337	...	(69)
Grand total			(1,442)	(14,034)	...	(2,127)	(2,167)	(2,310)	(2,464)	15,422	...	(2,109)	(2,667)	(2,474)	(1,925)	(13,845)	...	(1,451)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Production and Fe content figures are for concentrates, not ore.
[2] The Fe content of the Manchukuo mines is based on the estimated Fe content of the reserves, and hence does not apply to 1944 specifically.
[3] Estimated.

Source: Japan proper figures compiled from data supplied by Japan Iron & Steel Control association (TEKKO TOSEI KAI); Manchukuo figures compiled from data supplied by former officials of Manchurian Industrial Development company in Tokyo; and China figures from data supplied by the Japan Iron Mfg. Co., November 1945.

APPENDIX TABLE 4.—*Iron ore, iron sands, and pyrite sinters supply in Japan proper, fiscal years 1931–45*

[In thousands of metric tons]

Year	Domestic supply				Imports of iron ore	Total	Iron ore stockpile period end
	Iron ore production	Iron sands production	Pyrite sinter deliveries	Total			
1931	208	1	na	(209)	1,727	(1,936)	na
1932	227	5	na	(232)	1,634	(1,866)	na
1933	320	1	na	(321)	1,779	(2,100)	na
1934	432	2	na	(434)	2,312	(2,746)	na
1935	516	6	na	(522)	3,646	(4,168)	3,195
1936	619	4	na	(623)	4,023	(4,646)	4,362
1937	584	13	na	(597)	4,313	(4,910)	4,151
1938	766	71	na	(837)	3,212	(4,049)	4,228
1939	850	52	na	(902)	4,949	(5,851)	3,952
1940	993	134	na	(1,127)	5,719	(6,846)	3,812
1941:							
I	na	na	na	na	1,707	na	
II	na	na	na	na	1,536	na	
III	na	na	na	na	935	na	
IV	na	na	na	na	880	na	
Total	1,334	233	na	(1,567)	5,058	(6,625)	2,605
1942:							
I	429	72	na	(501)	1,054	(1,555)	
II	709	125	na	(834)	1,250	(2,084)	
III	497	81	na	(578)	1,356	(2,034)	
IV	424	90	na	(514)	1,220	(1,734)	
Total	2,059	368	[1]362	2,789	4,880	7,669	1,399
1943:							
I	590	112	na	(702)	1,268	(1,970)	
II	831	142	na	(973)	940	(1,913)	
III	669	102	na	(771)	736	(1,507)	
IV	618	71	na	(689)	742	(1,431)	
Total	2,708	427	703	38,38	3,686	7,524	792
1944:							
I	756	130	124	1,010	692	1,702	
II	1,128	160	86	1,374	458	1,832	
III	886	110	80	1,076	312	1,388	
IV	817	82	50	949	206	1,155	
Total	3,587	482	340	4,409	1,668	6,077	672
1945:							
I	701	91	45	837	143	980	na

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Includes only consumption at Japan Iron Manufacturing company, Yawata plant.

Source: Compiled from data supplied by Japan Iron and Steel Control association (Tekko Tosei Kai) and reports by individual iron and steel plants, November 1945.

APPENDIX TABLE 5.—*Metallurgical coke production by plants, Japan proper, Korea and Manchukuo, fiscal years 1931–45*

[In thousands of metric tons]

Company	Location	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944 (by quarter)					1945
															I	II	III	IV	Total	I
Japan proper																				
Japan Iron Mfg. Co	Yawata, Kyushu	na	na	na	1,337	1,371	1,425	1,680	1,791	1,926	1,931	1,990	2,037	1,950	474	359	404	359	1,596	215
Japan Iron Mfg. Co	Wanishi, Hokkaido	na	na	na	200	233	228	239	260	359	498	697	773	767	165	147	112	92	516	82
Japan Steel Tube Co	Kawasaki, Honshu	...	...	...	...	...	144	242	396	472	519	602	655	599	141	120	106	79	446	47
Japan Iron Mfg. Co	Hirohata, Honshu	...	...	...	...	...	...	...	...	94	328	576	576	581	143	125	106	88	462	45
Japan Iron Mfg. Co	Kamaishi, Honshu	na	na	na	232	229	233	228	241	335	363	394	344	326	94	86	80	72	332	69
Nakayama Steel Co	Osaka, Honshu	...	...	...	...	...	...	...	...	77	131	223	270	208	45	21	...	...	66	...
Amagasaki Iron Mfg. Co	Amagasaki, Honshu	...	...	...	...	...	...	...	...	...	...	85	123	89	18	10	...	...	28	...
Asano Heavy Industry Co	Kokura, Kyushu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Other companies (gas and chemical)		na	na	na	na	na	na	na	[1] 4	[1] 88	[1] 110	[1] 124	705	638	157	155	110	112	534	na
Total		na	na	na	(1,769)	(1,833)	(2,030)	(2,389)	(2,692)	(3,351)	(3,880)	(4,691)	5,483	5,158	1,237	1,023	918	802	3,980	(458)
Korea																				
Japan Iron Mfg. Co	Kenjiho	na	na	na	201	203	204	279	356	355	329	372	337	379	104	98	87	59	348	48
Japan Iron Mfg. Co	Seishin	...	...	...	...	...	...	...	...	...	...	...	150	317	103	108	93	65	369	32
Total		na	na	na	21	203	204	279	356	355	329	372	487	696	207	206	180	124	717	80
Manchukuo																				
Manchukuo Iron Mfg. Co	Anshan	na	304	307	357	480	539	717	876	1,140	1,155	1,452	1,575	1,644	413	227	227	261	1,128	na
Manchukuo Iron Mfg. Co	[2]Penhsihuti	na	184	176	203	205	204	174	167	267	203	338	449	586	155	155	121	122	553	na
Total		na	488	483	560	685	743	891	1,043	1,407	1,358	1,790	2,024	2,230	568	382	348	383	1,681	na
Grand total		na	(488)	(483)	(2,530)	(2,721)	(2,977)	(3,559)	(4,091)	(5,113)	5,567	6,853	7,994	8,084	2,012	1,611	1,446	1,309	6,378	(538)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Data on metallurgical coke production by gas companies not available prior to 1942.
[2] Two plants.

Source: Compiled from reports by individual companies to USSBS, November 1945. Production of open pit and beehive coking facilities in Korea and Occupied China has not been estimated.

APPENDIX TABLE 6.—*Pig-iron imports to Japan proper by source, fiscal years 1931–45*

[Expressed as percentage of total imports]

Year	Korea	Manchukuo	China	British India	Other	Total	
						Amount[1]	Percent
1931	19	...	16	30	35	494	100
1932	32	50	...	18	...	650	100
1933	20	57	...	22	1	800	100
1934	21	53	...	26	...	777	100
1935	12	35	...	31	22	1,093	100
1936	11	25	...	30	34	1,095	100
1937	12	19	[2]	25	44	1,131	100
1938	20	20	[2]	31	29	1,072	100
1939	24	38	...	32	6	927	100
1940	20	50	...	30	...	854	100
1941	18	71	[2]	10	1	784	100
1942	15	81	4	...	...	878	100
1943	24	60	16	...	...	1,134	100
1944	26	62	12	...	...	942	100
1945							
1st qtr	60	39	1	...	...	51	100

[1] In thousands of metric tons.
[2] Less than 0.5 percent.

Source: Compiled from data supplied by Japan Iron & Steel Control association (Tekko Tosei Kai), November 1945.

APPENDIX TABLE 7.—*Pig-iron and iron production by plant, Japan proper, Korea, Manchukuo and China, fiscal years 1934–4*

[In thousands of metric tons]

Company	Location	1934	1935	1936	1937	1938	1939	1940	1941 (by quarter)				
									I	II	III	IV	Tota
Japan proper													
Japan Iron Mfg. Co.	Yawata, Kyushu	1,177	1,294	1,330	1,467	1,525	1,788	1,632	463	442	403	421	1,7
Japan Iron Mfg. Co.	Wanishi, Hokkaido	219	255	251	223	255	286	391	124	139	169	146	5
Japan Steel Tube Co.	Kawasaki, Honshu	...	...	118	245	338	395	419	108	116	125	118	4
Japan Iron Mfg. Co.	Hirohata, Honshu	...	...	...	...	...	37	224	126	107	114	120	4
Japan Iron Mfg. Co.	Kamaishi, Honshu	249	240	244	242	228	303	335	97	90	92	91	3
Nakayama Steel Co.	Osaka, Honshu	...	...	...	...	...	69	119	na	na	na	na	1
Amagasaki Iron Mfg. Co.	Amagasaki, Honshu	...	...	...	...	...	...	...	na	19	23	22	
Asano Heavy Industry Co.	Kohura, Kyushu	...	...	...	...	...	41	69	22	21	20	21	
Japan Steel Tube Co.	Tsurumi, Honshu	41	75	76	85	151	150	154	41	37	35	32	1
Kotobuki Steel Co.	Azumi Otsu, Honshu	na	na	na	na	na	na	29	9	8	8	6	
Other companies (non-blast furnace) [1]	...	41	42	35	56	95	110	95	na	na	na	na	1
Total	...	(1,727)	(1,906)	(2,054)	(2,318)	(2,592)	(3,179)	(3,467)	(990)	(979)	(989)	(977)	4,1
Korea													
Japan Iron Mfg. Co.	Kenjiho [2]	211	211	209	226	295	290	238	71	70	72	66	2
Japan Iron Mfg. Co.	Seishin [2]	...	...	...	...	...	...	...	...	...	...	...	
Other companies (non-blast furnace) [1]	...	na	na	na	na	na	na	na	na	na	na	na	
Total	...	(211)	(211)	(209)	(226)	(295)	(290)	(238)	(71)	(70)	(72)	(66)	(
Manchukuo													
Manchukuo Iron Mfg. Co.	Anshan	347	472	491	677	713	880	952	na	na	na	na	1,
Manchukuo Iron Mfg. Co.	Penhsihu	153	154	157	134	142	145	122	na	na	na	na	
Total	...	500	626	648	811	855	1,025	1,074	na	na	na	na	1,
China [3]													
Lungyeo Iron Works	Hsuanhua, Ioner Mongolia	...	...	...	...	...	...	...	...	...	...	...	...
Ioner Mongolia Ind. Co.	Hsuanhua, Ioner Mongolia	...	...	...	...	...	...	...	...	...	...	...	...
North China Iron Works	Shihchingshan, Hopei	...	...	...	...	...	...	...	...	...	...	...	...
North China Iron Works	Tangshan, Hopei	...	...	...	...	...	...	...	...	...	...	...	...
Nakayama Steel Co.	Tientsin, Hopei	...	...	...	...	...	...	...	...	...	...	...	...
North China Iron Works	Taiyuan, Shansi	...	...	...	...	...	...	...	...	...	...	...	...
North China Iron Works	Yangchuan, Shansi	...	...	...	...	...	...	...	...	...	...	...	...
Japan Steel Tube Co.	Tsingtao, Shantung	...	...	...	...	...	...	...	...	...	...	...	...
Japan Iron Mfg. Co.	Maanshan, Anwhei	...	...	...	...	...	...	...	...	...	...	...	...
Total	...	...	...	...	...	...	...	...	...	...	...	...	...
Grand total	...	(2,438)	(2,743)	(2,911)	(3,355)	(3,742)	(4,494)	(4,779)	(1,061)	(1,049)	(1,061)	(1,043)	(5,9

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Includes spooge iron (luppe), charcoal pig iron, and electric pig iron.
[2] The small blast furnace plants at Kenjiho and Seishin are not included. Only annual production figures for the fiscal year 1943 are available: Kenjiho, 20,000 tons; Seish 8,000 tons.
[3] Production data on the Tayeh Iron work, Tayeh, Hopei Province is not available. It is believed to have discontinued operations in late 1943 as a result of damage from air attac

Source: Compiled from reports to USSBS by individual plants, November 1945. Japan Iron Mfg. Co. gathered data on China.

PPENDIX TABLE 7.—*Pig-iron and iron production by plant, Japan proper, Korea, Manchukuo and China, fiscal years 1934–45*—Con.

[In thousands of metric tons]

Company	Location	1942 (by quarter)					1943 (by quarter)					1944 (by quarter)					1945
		I	II	III	IV	Total	I	II	III	IV	Total	I	II	III	IV	Total	I
Japan proper																	
ban Iron Mfg. Co.	Yawata, Kyushu	432	414	453	449	1,748	415	402	426	403	1,646	371	252	282	210	1,115	133
ban Iron Mfg. Co.	Wanishi, Hokkaido	185	181	197	212	775	182	143	148	132	605	133	120	98	76	427	89
ban Steel Tube Co.	Kawasaki, Honshu	118	122	119	111	470	92	64	64	47	267	92	64	61	47	267	12
ban Iron Mfg. Co.	Hirohata, Honshu	110	70	68	118	366	69	105	131	154	459	134	96	84	72	386	51
ban Iron Mfg. Co.	Kamaishi, Honshu	88	82	76	76	322	76	70	72	81	299	83	72	63	56	274	48
kayama Steel Co.	Osaka, Honshu	43	42	53	53	191	45	38	38	37	158	21	5	-		26	5
agasaki Iron Mfg. Co.	Amagasaki, Honshu	22	27	30	21	100	14	17	20	19	70	8	3			11	na
ino Heavy Industry Co.	Kokura, Kyushu	20	18	20	20	78	15	13	16	15	59	10	3	2	2	17	1
ban Steel Tube Co.	Tsurumi, Honshu	33	30	31	26	120	21	19	20	19	79	12	9	8	9	38	1
tobuki Steel Co.	Azumi Otsu, Honshu	6	5	6	6	23	5	3	3	2	13	2	-	-	-	2	-
ier companies (non-blast urnace) [1]		29	29	27	28	113	37	40	40	41	158	51	40	37	22	150	na
Total		1,086	1,020	1,080	1,120	4,306	971	914	978	950	3,813	917	664	638	494	2,713	(340)
Korea																	
ban Iron Mfg. Co.	Kenjiho [2]	56	58	79	75	268	81	70	69	62	282	70	70	60	37	237	26
ban Iron Mfg. Co.	Seishin [2]	9	27	20	39	95	55	42	56	48	201	53	56	49	40	198	26
ier companies (non-blast urnace) [1]		na	35	.....	37	72	19	18	19	17	73	21	19	12	9	61	na
Total		(65)	120	99	151	435	155	130	144	127	556	144	145	121	86	496	(52)
Manchukuo																	
ochukuo Iron Mfg. Co.	Anshan	na	na	na	na	1,328	na	na	na	na	1,325	327	157	180	209	872	na
nchukuo Iron Mfg. Co.	Penhsihu	na	na	na	na	307	na	na	na	na	403	na	217	na	157	374	na
Total		na	na	na	na	1,635	na	na	na	na	1,728	(327)	374	(180)	366	1,246	na
China [3]																	
ngyen Iron Works	Hsuanhua, Inner Mongolia	.....	.....	.....	.....	.....	.....	1	5	1	5	2	1	4	3	10	3
er Mongolia Ind. Co.	Hsuanhua, Inner Mongolia	.....	.....	.....	.....	.....	.....	.....	2	2	4	2	2	2	2	8	1
rth China Iron Works	Shihchingshan, Hopei	.....	.....	.....	.....	.....	1	1	6	6	14	3	4	6	2	15	2
rth China Iron Works	Tangshan, Hopei	.....	.....	.....	.....	.....	.....	1	4	6	11	10	12	17	14	53	6
kayama Steel Co.	Tientsin, Hopei	.....	.....	.....	.....	.....	.....	.....	3	2	5	4	4	9	3	20	2
rth China Iron Works	Taiyuan, Shansi	.....	.....	.....	.....	.....	.....	1	2	1	4	1	.....	1	.....	2	.....
rth China Iron Works	Yangchuan, Shansi	.....	.....	.....	.....	.....	.....	1	1	1	3	1	1	2	.....	4	1
ban Steel Tube Co.	Tsingtao, Shantung	.....	.....	.....	.....	.....	.....	.....	.....	1	1	6	9	15	7	37	7
ban Iron Mfg. Co.	Maanshan, Anwhei	.....	.....	.....	.....	.....	.....	.....	1	3	4	3	1	3	1	8	.....
Total		.....	.....	.....	.....	.....	1	5	22	23	51	32	34	59	32	157	22
Grand total		(1,151)	(1,140)	(1,179)	(1,271)	6,376	(1,127)	(1,049)	(1,144)	(1,100)	6,148	(1,420)	1,217	(998)	(978)	4,612	(414)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Includes sponge iron (luppe), charcoal pig iron, and electric pig iron.
The small blast furnace plants at Kenjiho and Seishin are not included. Only annual production figures for the fiscal year 1943 are available: Kenjiho, 20,000 tons; Seishin, 8,000 s.
[3] Production data on the Tayeh Iron work, Tayeh, Hopei Province is not available. It is believed to have discontinued operations in late 1943 as a result of damage from air attacks.

Source: Compiled from reports to USSBS by individual plants, November 1945. Japan Iron Mfg. Co. gathered data on China.

APPENDIX TABLE 8.—*Scrap steel and iron supply, consumption, and stockpiles, Japan proper, fiscal years 1931–45*

[In thousands of metric tons]

Year	Imports	Domestic purchased	Self-generated	Total	Consumption	Balance	Stockpiles
1931	296	800	286	1,382	1,106	276	1,389
1932	559	800	360	1,719	1,302	417	1,806
1933	1,013	1,100	478	2,591	1,905	686	2,492
1934	1,413	1,100	569	3,082	2,538	544	3,036
1935	1,692	1,100	681	3,473	3,122	351	3,387
1936	1,497	1,100	842	3,439	3,337	102	3,489
1937	2,420	1,100	1,894	5,414	4,394	1,020	4,509
1938	1,358	1,100	2,119	4,577	4,265	312	4,821
1939	2,555	890	2,185	5,630	4,660	970	5,791
1940	1,391	871	2,064	4,326	4,405	Δ79	5,712
1941	203	1,022	2,018	3,243	4,487	−1,244	4,468
1942	39	1,251	2,118	3,408	4,777	−1,369	3,099
1943	25	1,292	2,296	3,613	5,275	−1,662	1,437
1944	74	1,317	1,766	3,157	4,145	−988	449
1945	1	175	251	427	568	−141	308

(−) Indicates decrease;
Source: Compiled from data supplied by Japan Iron & Steel Control association (TEKKO TOSEI KAI), November 1945.

APPENDIX TABLE 9.—*Ingot-steel production by type, Japan proper, Korea, and Manchukuo, fiscal years, 1931–45*

[In thousands of metric tons]

Year and quarter	Japan proper														Korea			Manchukuo[3]	Grand total			
	Hokkaido			Honshu				Kyushu			Total											
	OH	E	Total	OH	B	E	Total	OH	E	Total	OH	B	E	Total	OH	E	Total	OH	OH	B	E	Tn
1931	na	na	13	na	.....	na	849	na	na	1,021	na	.....	na	1,883	.....	.....	.....	na	na	.....	na	(1,8
1932	na	na	35	na	.....	na	1,039	na	na	1,344	na	.....	na	2,398	.....	.....	.....	na	na	.....	na	(2,3
1933	na	na	77	na	.....	na	1,437	na	na	1,684	na	.....	na	3,198	na	.....	5	na	na	.....	na	(3,2
1934	na	na	77	na	.....	na	1,904	na	na	1,863	na	.....	na	3,844	na	.....	60	na	na	.....	na	(3,9
1935	77	[1]	77	2,303	.....	190	2,493	2,082	51	2,133	4,462	.....	241	4,703	97	.....	97	137	4,696	.....	241	4,
1936	65	.....	65	2,612	.....	246	2,858	2,224	70	2,294	4,901	.....	316	5,217	87	.....	87	344	5,332	.....	316	5,
1937	77	.....	77	2,986	.....	350	3,336	2,300	85	2,385	5,363	.....	435	5,798	103	.....	103	451	6,007	.....	435	6,
1938	74	2	76	3,095	59	634	3,788	2,477	120	2,597	5,646	59	756	6,461	103	3	106	622	6,371	59	759	7,
1939	81	2	83	3,058	152	780	3,990	2,514	106	2,620	5,653	152	888	6,693	94	17	111	562	6,309	152	905	7,
1940	79	2	81	2,981	233	939	4,153	2,479	142	2,621	5,539	233	1,083	6,855	94	15	109	554	6,187	233	1,098	7,
1941	118	3	121	2,695	333	1,053	4,081	2,470	165	2,635	5,283	333	1,221	6,837	108	49	157	573	5,964	333	1,270	7,
1942	252	4	256	2,717	352	1,224	4,293	2,358	192	2,550	5,327	352	1,420	7,099	128	53	181	724	6,179	352	1,473	8,
1943																						
I	87	2	89	717	80	387	1,184	571	77	648	1,375	80	466	1,921	29	[2] 18	47	214	1,618	80	484	2,
II	102	3	105	650	81	379	1,110	556	72	628	1,308	81	454	1,843	26	[2] 18	44	199	1,533	81	472	2,
III	110	3	113	732	86	439	1,257	590	78	668	1,432	86	520	2,038	27	[2] 18	45	210	1,669	86	538	2,
IV	126	3	129	727	84	423	1,234	590	66	656	1,443	84	492	2,019	26	[2] 18	44	214	1,683	84	510	2,
Total	425	11	436	2,826	331	1,628	4,785	2,307	293	2,600	5,558	331	1,932	7,821	108	72	180	837	6,503	331	2,004	8,
1944																						
I	113	3	116	663	67	460	1,190	523	64	587	1,299	67	527	1,893	28	[2] 15	43	207	1,534	67	542	2,
II	92	4	96	503	49	410	962	341	45	386	936	49	459	1,444	29	[2] 15	44	72	1,037	49	474	1,
III	74	4	78	450	49	423	922	404	66	470	928	49	493	1,470	26	[2] 15	41	94	1,048	49	508	1,
IV	41	3	44	305	32	311	648	346	66	412	692	32	380	1,104	12	[2] 15	27	64	768	32	395	1,
Total	320	14	334	1,921	197	1,604	3,722	1,614	241	1,855	3,855	197	1,859	5,911	95	60	155	437	4,387	197	1,919	6,
1945																						
I	na	na	40	na	na	na	466	na	na	296	[2] 435	.....	[2] 368	803	na	na	na	na	(435)	.....	(368)	(8

OH Indicates open hearth.
B Indicates basic Bessemer.
E Indicates electric furnace.
na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Less than 500 tons.
[2] Estimated.
[3] Anshan only. Steel is also made in a few other plants but their output is negligible.

Source: Compiled from data supplied by Japan Iron & Steel Control association (Tekko Tusei Kai), November 1945.

APPENDIX TABLE 10.—*Metallurgical coke, iron and steel annual capacity by plant, Japan proper, Korea, Manchukuo, China, 1937, 1941, 1944*

[In thousands of metric tons]

Company	Location	Metallurgical coke [1]			Pig iron [2]			Ingot steel									Finished steel								
								Open hearth			Electric			Total			Rolled products			Forged			Cast		
		1937	1941	1944	1937	1941	1944	1937	1941	1944	1937	1941	1944	1937	1941	1944	1937	1941	1944	1937	1941	1944	1937	1941	1944
Japan proper																									
Japan Iron Mfg. Co.	Yawata, Kyushu	1,517	2,123	2,470	1,825	2,100	2,100	2,282	2,422	2,492	17	50	165	2,299	2,472	2,657	2,151	2,488	2,504	27	27	61	.....	.....	12
Japan Iron Mfg. Co.	Wanshi, Hokkaido	219	821	1,080	420	950	1,155	.....	.....	500	.....	.....	3	560	[3] 1,110	503	780	940	180	.....	.....	.....	.....	.....	.....
Japan Steel Tube Co.	Kawasaki, Honshu	328	755	1,025	274	712	712	560	[3] 1,110	[3] 1,110	.....	.....	44	.....	.....	1,154	.....	.....	940	.....	.....	.....	.....	.....	.....
Japan Iron Mfg. Co.	Hirohata, Honshu	.....	918	918	.....	700	700	.....	200	600	.....	.....	.....	.....	200	600	.....	.....	450	.....	.....	.....	.....	.....	.....
Japan Iron Mfg. Co.	Kamaishi, Honshu	186	416	489	500	500	578	227	587	587	.....	.....	18	227	587	605	260	380	380	.....	.....	.....	.....	.....	.....
Nakayama Steel Co.	Nakayama, Honshu	.....	412	412	.....	365	365	229	229	236	.....	.....	7	229	229	243	337	280	280	.....	.....	2	2	2	2
Amagasaki Steel Works	Amagasaki, Honshu	.....	150	150	.....	128	128	116	166	166	.....	.....	15	116	166	181	90	238	238	.....	7	10	.....	.....	.....
Asano Heavy Industry	Kokura, Kyushu	.....	.....	114	.....	129	256	86	161	115	3	3	6	89	164	121	138	138	183	.....	.....	.....	.....	.....	.....
Japan Steel Tube Co.	Tsurumi, Honshu	.....	.....	.....	182	182	182	280	380	380	.....	.....	.....	280	380	380	306	516	516	.....	.....	.....	.....	.....	.....
Army Arsenals	Osaka and Nagoya	.....	.....	.....	.....	.....	.....	21	21	36	14	122	128	35	143	164	.....	.....	10	21	33	82	15	15	15
Navy Arsenals	.....	.....	31	31	.....	46	46	143	143	214	66	87	275	209	230	489	42	42	55	83	101	106	na	na	na
All other plants	.....	.....	.....	.....	.....	.....	.....	2,209	3,702	4,010	[8] 500	[8] 1,338	2,558	2,709	5,040	6,568	2,579	3,493	3,411	na	na	438	na	na	513
Total	.....	2,250	5,626	6,689	3,201	5,812	6,222	6,153	[9] 9,121	[3] 10,446	[8] 600	[8] 1,600	3,219	6,753	10,721	13,665	6,683	8,513	9,147	na	na	699	na	na	(542)
Korea																									
Japan Iron Mfg. Co.[4]	Kenjihn	306	306	379	350	350	420	150	150	150	.....	.....	.....	150	150	150	170	170	170	.....	.....	.....	.....	.....	.....
Japan Iron Mfg. Co.[5]	Seishin	.....	.....	452	.....	70	490	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
All other plants[6]	.....	na	na	na	na	na	na	.....	.....	.....	na	na	112	na	na	112	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	.....	(306)	(306)	(831)	(350)	(420)	(910)	150	150	150	na	na	112	(150)	(150)	262	170	170	170	.....	.....	.....	.....	.....	.....
Manchukuo																									
Manchukuo Iron Mfg. Co.	Anshan	955	2,075	2,075	698	1,700	1,950	585	585	1,330	.....	.....	.....	585	585	1,330	410	410	480	.....	.....	.....	.....	.....	.....
Manchukuo Iron Mfg. Co.[7]	Penhsihu	270	750	750	137	550	550	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
All other plants	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	na	na	27	na	na	27	na	na	275	.....	.....	.....	.....	.....	.....
Total	.....	1,225	2,825	2,825	835	2,250	2,500	585	585	1,330	na	na	27	(585)	(585)	1,357	410	410	755	.....	.....	.....	.....	.....	.....
China																									
Lungyen Iron Works	Hsuanhua, Inner Mongolia	.....	.....	na	.....	.....	77	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Inner Mongolian Ind. Co.	Hsuanhua, Inner Mongolia	.....	.....	na	.....	.....	140	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
North China Iron Works	Shihchingshan, Hopei	.....	.....	na	.....	.....	28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
North China Iron Works	Tangshan, Hopei	.....	.....	na	.....	.....	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nakayama Steel Co.	Tientsin, Hopei	.....	.....	na	.....	.....	35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
North China Iron Works	Taiyuan, Shansi	.....	.....	na	.....	.....	175	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
North China Iron Works	Yangchuan, Shansi	.....	.....	na	.....	.....	70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Japan Steel Tube Co.	Tsiogtao, Shantung	.....	.....	na	.....	.....	85	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Japan Iron Mfg. Co.	Maanshan, Anwhei	.....	.....	na	.....	.....	74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tayeh Iron Works	Tayeh, Hopei	.....	na	na	.....	175	175	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	.....	.....	.....	na	.....	175	866	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Grand total	.....	(3,781)	(8,757)	(10,345)	(4,386)	(8,657)	(10,498)	6,888	[9] 9,856	[3] 11,926	(600)	(1,600)	3,358	(7,488)	(11,456)	15,284	7,263	9,093	10,072	na	na	699	na	na	(542)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] 365 days per year basis. Beehive and pit coking facilities in Korea and China have not been included.
[2] Rated capacity x 350 days.
[3] Included 500,000 toos basicBessemer (Thomas) capacity.
[4] Includes small blast furnace plant.
[5] Includes small blast furnace plant and rotary kilns.
[6] Data on Heijn, Keijo and Chinnampo small blast furnace plants not available.
[7] Includes twn plants, Penhsihu and Miyanehara.
[8] Estimated.

Source: Compiled from data supplied by Iron and Steel Control association (TEKKO TOSEI KAI) and reports to USSBS by individual plants November 1945. Japan Iron Mfg. Co. gathered the data on China.

APPENDIX TABLE 11.—*Rolled-steel products, annual capacity, Japan proper, Korea, and Manchukuo, fiscal years 1937, 1941, 1944.*

[In thousands of metric tons]

Area	Year	Rails	Shapes	Bars	Sheets and tin plates	Wire rods	Plates	Pipes and tubes	Other	Total
Japan proper										
Hokkaido	1937	....	30	230	.....	....	....	....	....	260
	1941	....	30	350	.....	....	....	....	....	380
	1944	.....	30	350	....	180	.....	....	....	560
Honshu	1937	.....	290	1,334	584	370	656	575	343	4,152
	1941	.....	394	1,892	639	370	1,314	575	343	5,527
	1944	.....	394	1,892	606	334	1,660	637	343	5,866
Kyushu	1937	300	319	637	186	222	520	.....	87	2,271
	1941	300	369	683	425	222	520	.....	87	2,606
	1944	300	369	798	425	222	520	.....	87	2,721
Total	1937	300	639	2,201	770	592	1,176	575	430	6,683
Total	1941	300	793	2,925	1,064	592	1,834	575	430	8,513
Total	1944	300	793	3,040	1,031	736	2,180	637	430	9,147
Korea	1937	....	70	....	....	....	100	....	....	170
	1941	....	70	....	....	....	100	....	....	170
	1944	....	70	....	....	....	100	....	....	170
Manchukuo	1937	.....	.....	370	40	.....	.....	.....	.....	410
	1941	.....	.....	370	40	.....	.....	.....	.....	410
	1944	.....	.....	520	40	.....	140	55	.....	755
Grand total	1937	300	709	2,571	810	592	1,276	575	430	7,263
Grand total	1941	300	863	3,295	1,104	592	1,934	575	430	9,093
Grand total	1944	300	863	3,560	1,071	736	2,420	692	430	10,072

Source: Compiled from data supplied by Japan Iron & Steel Control association (Tekko Tosei Kai), by former officials of Manchurian Iron & Steel company in Tokyo, and by the Bureau of Military Affairs of the Navy Department and the Bureau of Military Affairs of the War Department, November 1945.

APPENDIX TABLE 12.—*Finished steel production, Japan proper, Korea, and Manchukuo, fiscal years 1931–45*

[In thousands of metric tons]

Year and quarter	Japan proper [1]																				
	Hokkaido					Honshu					Kyushu					Total					
	Ordinary			Special	Total	Ordinary			Special	Total	Ordinary			Special	Total	Ordinary			Special	T
	Rolled	Cast	Forged			Rolled	Cast	Forged			Rolled	Cast	Forged			Rolled	Cast	Forged		
1931	....	2	5	3	10	871	20	9	7	907	731	9	3	4	747	1,602	31	17	14	1,
1932	....	3	10	6	19	1,046	36	16	12	1,104	964	10	6	10	990	2,010	43	32	28	2,
1933	10	3	16	8	37	1,397	46	35	24	1,502	1,209	14	13	18	1,254	2,616	63	64	50	2,
1934	10	4	16	10	40	1,667	58	39	29	1,793	1,437	18	16	19	1,490	3,114	80	71	58	3,
1935	5	4	16	7	32	2,254	74	37	70	2,435	1,486	22	19	27	1,554	3,745	100	72	104	4,
1936	3	6	19	8	36	2,712	84	43	90	2,929	1,557	26	20	26	1,629	4,272	116	82	124	4,
1937	5	6	20	10	41	3,056	123	49	166	3,394	1,619	29	28	36	1,712	4,680	158	97	212	5,
1938	4	7	21	16	48	2,985	194	68	266	3,513	1,887	33	41	46	2,007	4,876	234	130	328	5,
1939	2	8	25	17	52	2,689	222	88	405	3,404	1,985	29	38	41	2,093	4,676	259	151	463	5,
1940	....	6	28	15	49	2,689	201	106	411	3,407	1,843	29	39	17	1,928	4,532	236	173	443	5,
1941:																				
I & II	....	na	na	na	na	1,173	na	na	na	(1,173)	895	na	na	na	(895)	2,068	na	na	na	(2,
III & IV	....	na	na	na	na	1,164	na	na	na	(1,164)	921	na	na	na	(921)	2,085	na	na	na	(2,
Total	....	6	24	20	50	2,337	253	116	462	3,168	1,816	27	42	17	1,902	4,153	286	182	499	5,
1942:																				
I	....	na	na	na	na	529	na	na	na	(529)	504	na	na	na	(504)	1,033	na	na	na	(1,
II	....	na	na	na	na	484	na	na	na	(484)	438	na	na	na	(438)	922	na	na	na	(9
III	3	na	na	na	na	554	na	na	na	(554)	464	na	na	na	(464)	1,021	na	na	na	(1,
IV	5	na	na	na	na	595	na	na	na	(595)	476	na	na	na	(476)	1,076	na	na	na	(1,
Total	8	6	27	34	75	2,162	256	115	599	3,132	1,882	27	33	17	1,959	4,052	289	175	650	5,
1943:																				
I	6	2	9	11	28	582	68	32	180	862	479	7	12	13	511	1,067	77	53	204	1,
II	7	2	8	14	31	544	67	29	171	811	432	8	12	13	465	983	77	49	198	1,
III	9	3	10	12	34	575	76	29	204	884	435	8	13	15	471	1,019	87	52	231	1,
IV	13	3	9	14	39	602	76	31	235	944	465	9	14	41	529	1,080	88	54	290	1,
Total	35	10	36	51	132	2,303	287	121	790	3,501	1,811	32	51	82	1,976	4,149	329	208	923	5,
1944:																				
I	15	4	8	20	47	555	79	31	255	920	400	10	12	40	462	970	93	51	315	1,
II	13	3	11	18	45	376	73	27	249	725	230	8	8	35	281	619	84	46	302	1,
III	10	3	11	16	40	331	75	26	240	672	278	9	11	49	347	619	87	48	305	1,
IV	....	1	9	13	23	202	57	16	198	473	222	7	8	48	285	424	65	33	259	7
Total	38	11	39	67	155	1,464	284	100	942	2,790	1,130	34	39	172	1,375	2,632	329	178	1,181	4,3
1945: [2] I	4	2	1	13	20	125	42	9	120	296	128	7	5	36	176	257	51	15	169	4

See footnotes at end of table.

APPENDIX TABLE 12.—*Finished steel production, Japan proper, Korea, and Manchukuo, fiscal years 1931–35*—Continued

[In thousands of metric tons]

Year and quarter	Japan Proper [1]—Continued														
	Korea					Manchukuo [2]					Grand total [3]				
	Ordinary			Special	Total	Ordinary			Special	Total	Ordinary			Special	Total
	Rolled	Cast	Forged			Rolled	Cast	Forged			Rolled	Cast	Forged		
1931	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,602	31	17	14	1,664
1932	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,010	43	32	28	2,113
1933	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,616	63	64	50	2,793
1934	22	.....	.....	.....	22	.....	.....	.....	.....	.....	3,136	80	71	58	3,345
1935	52	.....	.....	.....	52	141	.....	.....	.....	141	3,938	100	72	104	4,214
1936	57	.....	.....	.....	57	303	na	na	na	(303)	4,632	(116)	(82)	(124)	(4,954)
1937	66	.....	.....	.....	66	417	na	na	na	(417)	5,163	(158)	(97)	(212)	(5,630)
1938	91	.....	.....	1	92	480	6	2	2	490	5,447	240	132	331	6,150
1939	76	6	.....	7	89	417	12	4	1	434	5,169	277	155	471	6,072
1940	75	.....	.....	7	82	433	2	3	.....	438	5,040	238	176	450	5,904
1941:															
I & II	39	na	na	na	(39)	na	na	na	na	na	(2,107)	na	na	na	(2,107)
III & IV	46	na	na	na	(46)	na	na	na	na	na	(2,131)	na	na	na	(2,131)
Total	85	11	2	14	112	325	5	3	.....	333	4,563	302	187	513	5,565
1942:															
I	24	na	na	na	(24)	na	na	na	na	na	(1,057)	na	na	na	(1,057)
II	25	na	na	na	(25)	na	na	na	na	na	(947)	na	na	na	(947)
III	27	na	na	na	(27)	na	na	na	na	na	(1,048)	na	na	na	(1,048)
IV	27	na	na	na	(27)	na	na	na	na	na	(1,103)	na	na	na	(1,103)
Total	103	12	2	16	133	339	13	14	9	375	4,494	314	191	675	5,674
1943:															
I	26	.....	.....	3	29	na	na	na	na	na	(1,093)	(77)	(53)	(207)	(1,430)
II	23	.....	.....	3	26	na	na	na	na	na	(1,006)	(77)	(49)	(201)	(1,333)
III	24	.....	.....	3	27	na	na	na	na	na	(1,043)	(87)	(52)	(234)	(1,416)
IV	22	.....	.....	3	25	na	na	na	na	na	(1,102)	(88)	(54)	(293)	(1,537)
Total	95	.....	.....	12	107	542	7	11	9	569	4,786	336	219	944	6,285
1944: [4]															
I	22	.....	.....	5	27	106	na	na	na	(106)	1,098	(93)	(51)	(320)	(1,562)
II	22	.....	.....	5	27	28	na	na	na	(28)	669	(84)	(46)	(307)	(1,106)
III	16	.....	.....	5	21	16	na	na	na	(16)	651	(87)	(48)	(310)	(1,096)
IV	8	.....	.....	5	13	79	na	na	na	(79)	511	(65)	(33)	(264)	(873)
Total	68	.....	.....	20	88	229	[5] 4	[5] 6	[5] 5	244	2,929	333	184	1,206	4,652
1945: [4] I	12	.....	.....	.....	12	[5] 20	.....	.....	.....	20	289	51	15	169	524

na Indicates data are not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Shikoku production, which in no year exceeded 6,000 tons, has been omitted.
[2] Data limited to Manchukuo Iron Mfg. Co. production at Anshan, except for year 1943.
[3] Production in Occupied China, which in no year exceeded 500 tons, has been omitted.
[4] "Special Steel Demand and Supply Regulations," 28 Jan. 1944, broadened the "special" steel category to include certain high carbon steels formerly termed "ordinary."
[5] Estimated.

Source: Compiled from data supplied by the Iron & Steel Control association (Tekko Tosei Kai) and by the Military Affairs Bureaus of the War and Navy Departments. Such data, insofar as they include since 1935 production in Army and Navy arsenals (which in no year exceeded 225,000 tons), are estimated for the years prior to 1940. Cast and forged steel data are limited to steel cast and forged in iron and steel producing plants.

APPENDIX TABLE 13.—*Rolled steel production, by product, Japan proper, fiscal years 1935–45*

[In thousands of metric tons]

Year and quarter	Rails	Shapes	Bars	Sheets and tin plates	Wire rods	Plates	Pipes and tubes	Other	Total
1935	367	468	1,025	484	413	713	167	108	3,745
1936	289	555	1,034	660	487	878	189	180	4,272
1937	217	728	1,207	609	447	1,063	224	185	4,680
1938	283	664	1,321	521	401	1,280	226	180	4,876
1939	361	600	1,268	423	383	1,177	270	194	4,676
1940	366	635	1,258	572	350	822	261	288	4,532
1941:									
I and II	142	305	571	266	180	390	125	89	2,068
III and IV	150	276	630	239	165	416	124	85	2,085
Total	292	581	1,201	505	345	806	249	174	4,153
1942:									
I	80	156	264	111	85	229	56	52	1,033
II	64	146	236	86	67	220	53	50	922
III	63	146	247	100	90	258	63	54	1,021
IV	55	134	245	99	97	330	66	50	1,076
Total	262	582	992	396	339	1,037	238	206	4,052
1943:									
I	48	126	251	98	92	353	64	35	1,067
II	44	115	213	93	75	349	68	26	983
III	41	124	221	90	71	366	73	33	1,019
IV	38	114	217	91	74	407	81	58	1,080
Total	171	479	902	372	312	1,475	286	152	4,149
1944:									
I	25	124	189	80	55	382	82	33	970
II	9	55	136	62	37	240	59	21	619
III	20	54	131	72	56	210	53	23	619
IV	24	33	103	49	22	139	32	22	424
Total	78	266	559	263	170	971	226	99	2,632
1945: I	10	11	83	29	20	62	26	16	257

Source: Compiled from data supplied by Iron & Steel Control association (Tekko Tosei Kai), November 1945.

APPENDIX TABLE 14. *Finished steel distribution, Japon proper, fiscal years, 1937–45*

[In thousands of metric tons]

Consumer	Category	1937					1938					1939				
		Ordinary			Special	Total	Ordinary			Special	Total	Ordinary			Special	Total
		Rolled	Cast	Forged			Rolled	Cast	Forged			Rolled	Cast	Forged		
(A) *Army ground forces*	Artillery	.....	.....	.....	.....	.....	35.0	.....	.....	5.9	.....	48.0	.....	.....	9.4	.....
	Small arms	.....	.....	.....	.....	.....	28.0	.....	.....	6.2	.....	38.0	.....	.....	10.0	.....
	Ammunition	.....	.....	.....	.....	.....	85.0	.....	.....	20.0	.....	112.0	.....	.....	30.0	.....
	Vehicles	.....	.....	.....	.....	.....	49.0	.....	.....	8.8	.....	66.0	.....	.....	17.0	.....
	Equipment	.....	.....	.....	.....	.....	54.3	.....	.....	7.1	.....	69.7	.....	.....	11.1	.....
	Construction, expansion	.....	.....	.....	.....	.....	49.3	.....	.....	.3	.....	69.0	.....	.....	.....	.....
	Fuel	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Other	.....	.....	.....	.....	.....	67.2	.....	.....	2.6	.....	65.6	.....	.....	3.0	.....
	Total	224.0	25.2	18.1	na	(267.3)	367.8	41.3	29.0	50.6	488.7	468.3	51.5	29.2	80.5	629.5
(B) *Navy surface forces*	Guns, ammunition	29.1	.....	.....	4.8	.....	24.3	.....	.....	10.6	.....	25.2	.....	.....	16.5	.....
	Torpedoes, mines	46.8	.....	.....	2.9	.....	33.5	.....	.....	6.4	.....	34.8	.....	.....	10.0	.....
	Elec., navigation equipment	17.0	.....	.....	.6	.....	14.3	.....	.....	1.3	.....	14.8	.....	.....	2.1	.....
	Shipbuilding	274.0	.....	.....	.2	.....	228.3	.....	.....	.4	.....	237.2	.....	.....	.7	.....
	Engines	107.6	.....	.....	3.1	.....	84.7	.....	.....	6.9	.....	88.0	.....	.....	10.8	.....
	Civil construction	77.0	.....	.....	.4	.....	64.2	.....	.....	.9	.....	66.6	.....	.....	1.3	.....
	Other	38.5	.....	.....	.4	.....	32.3	.....	.....	.9	.....	32.9	.....	.....	1.3	.....
	Total	584.0	25.2	28.1	12.4	649.7	481.6	28.4	37.3	27.4	574.7	499.5	38.1	48.6	42.7	628.9
(Bx) *Merchant shipbuilding*	Shipbuilding	160.5	.....	.....	1.7	.....	168.4	.....	.....	1.5	.....	174.1	.....	.....	1.6	.....
	Engines	40.1	.....	.....	14.8	.....	42.0	.....	.....	13.3	.....	43.5	.....	.....	13.7	.....
	Yard construction	30.9	.....	.....	1.0	.....	19.7	.....	.....	.9	.....	88.0	.....	.....	.9	.....
	Repairs	61.8	.....	.....	2.1	.....	26.4	.....	.....	.9	.....	27.2	.....	.....	.9	.....
	Other	15.4	.....	.....	1.0	.....	6.5	.....	.....	.9	.....	6.8	.....	.....	.9	.....
	Total	308.7	19.3	12.1	20.6	360.7	263.0	29.5	16.6	17.5	326.6	272.0	34.3	14.6	18.0	338.9
(D) *Air forces*	Aircraft frames, fixtures	23.1	.....	.....	.....	.....	26.8	.....	.....	8.2	.....	27.5	.....	.....	6.8	.....
	Aircraft engines, fixtures	11.6	.....	.....	.....	.....	12.1	.....	.....	15.1	.....	12.5	.....	.....	13.3	.....
	Guns, bombs	47.7	.....	.....	.....	.....	57.6	.....	.....	3.4	.....	59.1	.....	.....	4.4	.....
	Torpedoes, mines	5.8	.....	.....	.....	.....	7.0	.....	.....	.4	.....	7.2	.....	.....	.6	.....
	Electrical instruments	5.4	.....	.....	.....	.....	5.5	.....	.....	.2	.....	5.7	.....	.....	.4	.....
	Optical instruments	2.7	.....	.....	.....	.....	2.7	.....	.....	.....	.....	2.8	.....	.....	.....	.....
	Base construction machinery	38.5	.....	.....	.....	.....	40.6	.....	.....	1.0	.....	42.2	.....	.....	1.5	.....
	Construction, repair	57.7	.....	.....	.....	.....	55.2	.....	.....	.6	.....	57.0	.....	.....	.8	.....
	Total	192.5	9.7	9.1	[5] 3.3	(214.6)	207.5	14.8	12.4	28.9	263.6	214.0	19.2	19.4	27.8	280.4
(Cx) *Railroads*	Rolling stock	210.5	.....	.....	.....	.....	156.2	.....	.....	.....	.....	142.8	.....	.....	.....	.....
	Rails, accessories	109.4	.....	.....	.....	.....	11.4	.....	.....	.....	.....	57.7	.....	.....	.....	.....
	Total	319.9	[4]	[4]	4.0	(323.9)	167.6	[4]	[4]	5.0	(172.6)	200.5	[4]	[4]	5.0	(205.5)
(C) *Industrial facilities construction repair, maintenance*	Iron and steel	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	397.4	.....	.....	.....	.....
	Light metals	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[7]	.....	.....	.....	.....
	Non-ferrous	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[7]	.....	.....	.....	.....
	Coal mining, handling	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	121.3	.....	.....	.....	.....
	Petroleum mining	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	71.7	.....	.....	.....	.....
	Petroleum, synthetic refining	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....	.....	.....	.....
	Chemical, explosive	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	37.6	.....	.....	.....	.....
	Cement	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[7]	.....	.....	.....	.....
	Electricity	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	38.2	.....	.....	.....	.....
	Gas	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21.4	.....	.....	.....	.....
	Pulp, paper	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[7]	.....	.....	.....	.....
	Other	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[7]	.....	.....	.....	.....
	Total	[1] 1,937.9	[4]	[4]	[6]	(1,937.9)	[1] 867.5	[4]	[4]	[6]	(867.5)	687.6	[4]	[4]	[4]	(687.6
(C) *Public works, construction*	.....	[1]	[4]	[4]	[6]	.....	[1]	[4]	[4]	[6]	.....	212.2	[4]	[4]	[6]	(212.2)
(C) *Machinery, tools* (Plant and production)	Machinery, industrial	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Machine tools	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Automotive	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Agriculture	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	[3] 615.7	[4]	[4]	[6]	(615.7)	[3] 615.9	[4]	[4]	[6]	(615.9)	[2] 759.4	[4]	[4]	[6]	(759.4)
(C) *Manufactured goods*	Containers	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Wire	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Tools	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Other	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	[3] 639.8	[4]	[4]	[6]	(639.8)	[3] 640.0	[4]	[4]	[6]	(640.0)	[3] 789.1	[4]	[4]	[6]	(789.1)
(C) *Exports*	Manchukuo	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	China	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Korea	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Formosa	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Karafuto	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	South Seas	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	785.2	[4]	[4]	[6]	(785.2)	813.9	[4]	[4]	[6]	(813.9)	934.8	[4]	[4]	[6]	(934.8)
	Miscellaneous	248.7	75.4	29.1	11.0	364.2	129.9	122.6	37.2	20.0	314.7	61.3	131.7	43.8	25.0	261.8
	Total "Cx" and "C"	4,547.2	75.4	29.1	15.0	4,666.3	3,234.8	122.6	37.2	25.0	3,419.6	3,644.9	131.7	43.8	30.0	3,850.4
	Grand total	5,856.4	154.8	96.5	[7] 1.3	(6,159.0)	4,554.7	236.6	132.5	149.4	5,073.2	5,098.7	274.8	155.6	199.0	5,728.1

See footnotes at end of table.

APPENDIX TABLE 14.—*Finished steel distribution, Japan proper, fiscal years, 1937–45*—Continued

[In thousands of metric tons]

Consumer	Category	1940					1941					1942				
		Ordinary			Special	Total	Ordinary			Special	Total	Ordinary			Special	Tot
		Rolled	Cast	Forged			Rolled	Cast	Forged			Rolled	Cast	Forged		
(A) *Army ground forces*	Artillery	47.0			14.0		65.7			17.6		52.3			17.6	
	Small arms	39.0			15.0		54.0			18.8		43.4			18.6	
	Ammunition	110.0			40.0		161.6			62.2		99.4			62.1	
	Vehicles	59.0			30.0		94.6			26.0		69.3			25.7	
	Equipment	66.6			16.2		103.6			20.9		80.8			21.2	
	Construction, expansion	80.8					111.7			.1		94.5				
	Fuel	68.9			.1		87.7			2.3		79.2			2.8	
	Other	98.7			5.5		129.5			5.5		78.4			5.9	
	Total	570.0	21.8	32.7	120.8	745.3	808.4	49.6	34.7	153.4	1,046.1	595.3	53.6	37.3	153.9	840.
(B) *Navy surface forces*	Guns, ammunition	30.6			72.0		85.6			100.0		71.8			152.0	
	Torpedoes, mines	40.0			35.0		50.0			40.0		54.6			45.0	
	Elec., navigation equipment	13.7			5.3		21.5			9.3		20.5			8.9	
	Shipbuilding	280.9			1.8		380.0			2.5		343.7			2.0	
	Engines	75.0			36.0		98.0			32.0		81.0			38.0	
	Civil construction	75.3			7.4		109.5			8.2		97.3			10.1	
	Other	49.5			7.4		76.7			8.2		61.4			10.1	
	Total	565.0	19.1	54.5	164.9	803.5	821.3	43.4	63.7	200.2	1,128.6	730.3	37.3	86.5	266.1	1,120
(Bx) *Merchant shipbuilding*	Shipbuilding	125.7			1.1		192.0			1.8		288.6			2.4	
	Engines	31.4			9.9		48.0			15.2		72.2			20.1	
	Yard construction	14.7			.6		22.5			1.0		33.8			1.3	
	Repairs	19.6			.7		30.0			1.0		45.1			1.3	
	Other	4.9			.7		7.5			1.0		11.3			1.3	
	Total	196.3	14.9	16.4	13.0	240.6	300.0	34.1	17.4	20.0	371.5	451.0	37.8	20.4	26.4	535.
(D) *Air forces*	Aircraft frames, fixtures	30.1			16.6		38.6			17.7		33.9			23.7	
	Aircraft engines, fixtures	13.8			30.8		19.5			32.3		17.0			44.8	
	Guns, bombs	74.5			18.4		95.7			22.1		88.1			28.2	
	Torpedoes, mines	7.8			3.2		10.4			3.5		9.5			4.3	
	Electrical instruments	6.9			1.2		9.1			1.6		8.2			1.9	
	Optical instruments	3.4					4.4					4.0				
	Base construction machinery	50.3			8.1		67.2			9.1		61.1			11.2	
	Construction, repair	63.5			3.1		96.8			3.9		85.0			4.6	
	Total	250.3	8.5	27.3	81.4	367.5	341.7	21.7	29.0	90.2	482.6	306.8	25.2	34.0	118.7	484.
(Cx) *Railroads*	Rolling stock															
	Rails, accessories															
	Total	193.0	(4)	(4)	6.0	(199.0)	214.6	(4)	(4)	7.0	(221.6)	162.0	(4)	(4)	9.6	(171.6
(C) *Industrial facilities construction, repair, maintenance*	Iron and steel	301.0					99.4					125.0				
	Light metals	15.0					15.8					23.0				
	Non-ferrous	50.0					56.8					44.0				
	Coal mining, handling	77.0					100.4					60.0				
	Petroleum mining	55.0					83.0					54.6				
	Petroleum, synthetic refining															
	Chemical, explosive	31.0					29.9					25.2				
	Cement	(7)					1.5					.8				
	Electricity	47.0					38.6					28.7				
	Gas	13.0					8.9					5.0				
	Pulp, paper	(7)					1.5					1.1				
	Other	(7)					(7)					(7)				
	Total	589.0	(4)	(4)	(5)	(589.0)	435.8	(4)	(4)	(6)	(435.8)	367.4	(4)	(4)	(6)	(367.4
(C) *Public works, construction*		140.0	(4)	(4)	(5)	(140.0)	52.3	(4)	(4)	(6)	(52.3)	52.4	(4)	(4)	(5)	(52.4
(C) *Machinery, tools* (Plant and production)	Machinery, industrial						549.8					311.0				
	Machine tools						21.5					21.3				
	Automotive						31.6					33.2				
	Agriculture											(7)				
	Total	[3]607.0	(4)	(4)	(5)	(607.0)	602.9	(4)	(4)	(6)	(602.9)	365.5	(4)	(4)	(6)	(365.5
(C) *Manufactured goods*	Containers															
	Wire															
	Tools															
	Other															
	Total	[3]615.0	(4)	(4)	(5)	(615.0)	379.0	(4)	(4)	(6)	(379.0)	489.0	(4)	(4)	(6)	(489.0
(C) *Exports*	Manchukuo											31.5				
	China											57.6				
	Korea											92.7				
	Formosa											13.2				
	Karafuto											7.6				
	South Seas											.7				
	Total	522.0	(4)	(4)	(6)	(522.0)	385.7	(4)	(4)	(6)	(385.7)	202.7	(4)	(4)	(6)	(202.7
	Miscellaneous	59.0	145.0	44.0	22.0	270.0	185.2	99.3	40.5	23.0	348.0	84.0	98.3	39.3	30.4	252.0
	Total "Cx" and "C"	2,725.0	145.0	44.0	28.0	2,942.0	2,255.5	99.3	40.5	30.0	2,425.3	1,723.0	98.3	39.3	40.0	1,900.6
	Grand total	4,306.6	209.3	174.9	408.1	5,098.9	4,526.7	248.3	185.3	493.8	5,454.1	3,806.4	252.2	217.5	605.1	4,881.2

See footnotes at end of table.

APPENDIX TABLE 14.—*Finished steel distribution, Japan proper, fiscal years, 1937–45*—Continued

[In thousands of metric tons]

Consumer	Category	1943					1944[5]					1945 (first quarter)				
		Ordinary			Special	Total	Ordinary			Special	Total	Ordinary			Special	Total
		Rolled	Cast	Forged			Rolled	Cast	Forged			Rolled	Cast	Forged		
(A) *Army ground forces*	Artillery	82.6			23.4		17.8			17.0		5.0			2.0	
	Small arms	55.3			24.9		20.8			18.0		6.6			2.5	
	Ammunition	124.7			83.1		29.7			60.0		8.3			8.3	
	Vehicles	76.2			34.7		52.7			25.0		9.5			3.4	
	Equipment	159.4			28.1		99.6			20.4		9.1			2.9	
	Construction, expansion	122.8					45.2			.4		10.4			.4	
	Fuel	105.8			4.3		67.3			5.7		12.0				
	Other	113.0			6.9		14.9			5.7		14.8			.9	
	Total	839.8	67.0	35.5	205.4	1,147.7	348.0	67.3	30.7	152.2	598.2	75.7	7.3	2.7	20.4	106.1
(B) *Navy surface forces*	Guns, ammunition	106.9			183.0		102.0			252.0		10.8			36.4	
	Torpedoes, mines	25.9			34.1		27.2			37.7		5.5			6.5	
	Elec., navigation equipment	35.9			6.2		37.9			5.8		3.6			1.1	
	Shipbuilding	350.0			2.6		220.7			1.5		16.0			.2	
	Engines	103.0			36.5		59.0			34.0		7.0			4.0	
	Civil construction	109.4			8.5		53.0			16.5		6.0			3.0	
	Other	90.6			8.5		64.0			20.0		22.0			3.2	
	Total	821.7	59.1	77.4	279.4	1,237.6	563.8	59.3	67.9	367.5	1,058.5	70.9	12.6	11.6	54.4	149.5
(Bx) *Merchant shipbuilding*	Shipbuilding	504.3			4.7		756.5			7.0		129.3			7.1	
	Engines	126.1			39.5		187.4			59.3		32.3			9.3	
	Yard construction	59.1			2.6		87.7			3.9		15.2			.6	
	Repairs	78.8			2.6		117.2			3.9		20.2			.6	
	Other	19.7			2.6		29.2			3.9		5.1			.6	
	Total	788.0	47.3	32.2	52.0	919.5	1,178.0	51.4	16.7	78.0	1,324.1	202.1	4.8	3.0	18.2	2 228.1
(D) *Air forces*	Aircraft frames, fixtures	41.0			34.0		43.4			90.3		6.0			15.2	
	Aircraft engines, fixtures	20.5			66.8		20.6			162.5		1.5			24.3	
	Guns, bombs	84.7			24.8		89.0			146.1		13.5			26.0	
	Torpedoes, mines	10.2			3.7		10.4			27.2		1.8			4.2	
	Electrical instruments	11.3			2.4		8.5			9.4		1.4			1.2	
	Optical instruments	5.7					4.2					.8				
	Base construction machinery	76.9			10.0		74.8			71.8		7.5			10.5	
	Construction, repair	106.7			5.1		108.6			29.2		11.0			4.8	
	Total	357.0	35.5	19.3	146.8	558.6	359.5	39.6	25.1	536.5	960.7	43.5	6.2	2.1	86.2	138.0
(Cx) *Railroads*	Rolling stock	100.5														
	Rails, accessories	58.0													3.1	
	Total	158.5	(6)	(6)	10.0	(168.5)	138.6	(6)	(6)	6.0	(144.6)	31.1	(6)	(6)		(34.2)
(C) *Industrial facilities, construction, repair, maintenance*	Iron and steel	274.9					88.8			.6		2.1			.1	
	Light metals	44.1					29.4			.3		.7			.6	
	Non-ferrous	23.4					18.8			1.7		.6			.3	
	Coal mining, handling	38.7					11.8			1.0		.7				
	Petroleum mining	2.2					1.0					6.7				
	Petroleum, synthetic refining	27.3					6.6			.2		.5				
	Chemical, explosive	11.0					14.5			.2						
	Cement	1.1					1.4									
	Electricity	18.4					4.2			.3		.1				
	Gas	3.1					1.3									
	Pulp, paper	.1														
	Other	1.0					.1									
	Total	445.3	(6)	(6)	(6)	(445.3)	177.9	(6)	(6)	4.3	(182.2)	11.4	(6)	(6)	1.0	(12.4)
(C) *Public works, construction*		12.7	(6)	(6)	(6)	(12.7)	2.0	(6)	(6)	.4	(2.4)		(6)	(6)	.3	(.3)
(C) *Machinery, tools* (Plant and production)	Machinery, industrial	155.2					83.6			7.7		3.0			1.0	
	Machine tools	26.4					12.3									
	Automotive	23.5					7.2			2.3		8.6			1.4	
	Agriculture	9.5					7.2									
	Total	214.6	(6)	(6)	(6)	(214.6)	110.3	(6)	(6)	10.0	(120.3)	11.6	(6)	(6)	2.4	(14.0)
(C) *Manufactured goods*	Containers	43.4					14.5					.1				
	Wire	210.7					74.3			.1		10.5			.1	
	Tools	3.6					2.6					.4				
	Other	121.5					59.4					7.2				
	Total	379.4	(6)	(6)	(6)	(379.4)	150.8	(6)	(6)	.1	(150.9)	18.2	(6)	(6)	.1	(18.3)
(C) *Exports*	Manchukuo	29.2								1.0					.3	
	China	28.6					18.8			.7		.1			.4	
	Korea	98.1					37.9			.8					.3	
	Formosa	13.6					1.1			.3						
	Karafuto	0.9					.6					.9				
	South Seas	1.5					.3									
	Total	177.9	(6)	(6)	(6)	(177.9)	58.7	(6)	(6)	2.8	(61.5)	1.0	(6)	(6)	1.0	(2.0)
	Miscellaneous	93.9	106.5	41.9	50.0	292.3	19.7	99.0	38.1	.4	157.2	3.2	17.8	5.2	.2	26.4
	Total "Cx" and "C"	1,482.3	106.5	41.9	60.0	1,690.7	656.0	99.0	38.1	23.9	817.0	76.6	17.8	5.2	8.1	107.6
	Grand total	4,288.8	315.4	206.3	743.6	5,554.1	3,107.3	316.6	178.5	1,158.2	4,760.6	468.7	48.7	34.6	187.3	729.3

[1] "Public works, etc.", included in "Industrial facilities, etc." [2] Excluding "Agriculture." [3] Including "Agriculture."
[4] "Cx" (railroads) and all other "C" categories included in "Miscellaneous" total. [5] Includes only Navy air force.
[6] "C" categories except "Cx" (railroads) included in "Miscellaneous" total. [7] Included in "Miscellaneous."
[8] "Special Steel Demand and Supply Regulations," 28 Jan. 1944, broadened the "special" steel category to include certain high carbon steels formerly termed "ordinary."

Source: Compiled from data supplied by the Iron and Steel Control association, by the Air General Ordnance and Metals Bureau of the Ministry of Commerce and Industry, and by the Military Affairs Bureaus of the War and Navy Departments. Such data, insofar as they include allocations to the military services, are reconstructed from recollection and personal notebooks of officials of the indicated bureaus. Cast and forged steel data are limited to such steel produced in iron and steel plants. (To facilitate use, where data are not available spaces have been left blank rather than marked "na." Figures in parentheses indicate partial totals where constituent figures are missing.)

APPENDIX TABLE 15.—*Finished steel distribution, Japan proper, fiscal years 1937–45* (Summary of TABLE 14)

[In thousands of metric tons]

Consumer category	1937				1938				1939				1940				1941				1942				1943				1944				1945 (First quarter)			
	Ordinary Rolled	%	Total Steel	%	Ordinary Rolled	%	Total Steel	%	Ordinary Rolled	%	Total Steel	%	Ordinary Rolled	%	Total steel	%	Ordinary Rolled	%	Total steel	%	Ordinary Rolled	%	Total steel	%	Ordinary Rolled	%	Total steel	%	Ordinary Rolled	%	Total steel	%	Ordinary Rolled	%	Total steel	%
A. Army ground forces	224	4	[1](267)	4	368	8	489	10	468	9	630	11	570	13	745	14	808	18	1,046	19	595	16	840	17	840	20	1,148	21	348	11	598	13	76	16	106	15
B. Navy surface forces	584	10	650	11	482	11	575	11	499	10	629	11	565	13	804	16	821	18	1,129	21	739	19	1,120	23	822	19	1,238	22	564	18	1,059	22	71	15	150	20
Bx. Merchant ship building	309	5	361	6	263	6	327	7	272	5	339	6	196	5	241	5	300	7	372	7	451	12	536	11	788	19	920	17	1,178	38	1,324	28	202	43	228	31
D. Air forces	193	3	[1](215)	3	208	4	264	5	214	4	280	5	250	6	368	7	342	8	483	9	307	8	485	10	357	8	559	10	360	12	961	20	44	9	138	19
Cx. Railroads	320	6	------	---	168	4	------	---	201	4	------	---	193	5	------	---	215	5	------	---	162	4	------	---	159	4	------	---	139	4	------	---	31	7	------	---
C. Industrial facilities	1,938	33	------	---	868	19	------	---	{688	14	}	---	{589	14	}	---	{436	10	}	---	{367	10	}	---	{445	10	}	---	{178	6	}	---	{ 11	2	}	---
C. Public works and construction									{212	4	}	---	{140	3	}	---	{ 52	1	}	---	{ 52	1	}	---	{ 13	---	}	---	{ 2	---	}	---	{------	---	}	---
C. Machinery and tools	616	11	4,666	76	616	13	3,420	67	{759	15	3,850	67	{697	14	2,942	58	{603	13	2,425	44	{366	10	1,901	39	{215	5	1,691	30	{110	3	817	17	{12	3	108	15
C. Manufactured goods	640	11			640	14			{789	16			{615	14			{379	8			{489	13			{379	9			{151	5			{18	4		
C. Exports	785	13	------	---	814	18	------	---	935	18	------	---	522	12	------	---	386	8	------	---	203	5	------	---	178	4	------	---	59	2	------	---	1	---	------	---
C. Miscellaneous	249	4	------	---	130	3	------	---	61	1	------	---	59	1	------	---	185	4	------	---	84	2	------	---	94	2	------	---	20	1	------	---	3	1	------	---
Grand total	5,858	100	[1](6,159)	100	4,557	100	5,075	100	5,099	100	5,728	100	4,306	100	5,100	100	4,527	100	5,455	100	3,806	100	4,882	100	4,290	100	5,556	100	3,107	100	4,759	100	469	100	730	100

[1] Includes no special steel distribution to the Army.

Source: Compiled from data supplied by the Iron and Steel Control association (Tekko Tosei Kai), by the Air General Ordnance and Metals Bureau of the Ministry of Commerce and Industry, and by the Military Affairs Bureaus of the War and Navy Departments. See Table 14 supra.

APPENDIX TABLE 16.—*Finished steel, balance of supply and demand in Japan proper, fiscal years 1932–45*

[In thousands of metric tons]

Year	Supply [1]			Demand [1]			Supply less demand
	Production	Imports	Total	Distribution	Exports	Total	
1932	2,113	226	2,339	2,185	300	2,485	−146
1933	2,793	394	3,187	2,692	435	3,127	62
1934	3,323	364	3,687	3,048	596	3,644	43
1935	4,021	306	4,327	3,145	823	3,968	359
1936	4,594	286	4,880	3,761	990	4,751	129
1937	5,147	701	5,848	5,374	785	6,159	−311
1938	5,568	190	5,758	4,259	814	5,073	685
1939	5,549	164	5,713	4,793	935	5,728	−115
1940	5,384	181	5,565	4,577	522	5,099	466
1941	5,120	52	5,172	5,068	386	5,454	−282
1942	5,166	6	5,172	4,678	203	4,881	291
1943	5,609	.....	5,609	5,376	178	5,554	55
1944	4,320	.....	4,320	4,699	62	4,761	−441
1945:							
I	492	.....	492	728	1	729	−237

[1] For the years 1932–36, all figures include only ordinary rolled steel. For the years 1937–43, "Exports" figures include ordinary rolled steel only; exports of other steel are included in "Distribution." For the years 1944–45, exports of ordinary rolled and special steel are included in "Exports," of cast and forged ordinary steel in "Distribution."

Source: Appendix Tables 14 and 15. Import and export data are from the Iron & Steel Control association (Tekko Tosei Kai), November 1945.

APPENDIX TABLE 17.—*Ordinary rolled-steel distribution in Manchukuo, 1942–45*

[In thousands of metric tons]

Consumer category	1943 [1]		1944	
	Ton	Per cent	Ton	Per cent
Military and semi-military uses	222	39	99	38
Industrial facilities	244	45	128	49
Air defense, reconstruction, dispersion	.....	.....	8	3
Machinery	55	9	14	5
Civilian requirements	10	2	4	2
Exports	29	5	9	3
Total	560	100	262	100

[1] Estimated.

Source: Compiled from data furnished by officials of Manchukuo Iron Mfg. Co., November 1945.

APPENDIX TABLE 19.—*Pig-iron distribution in Manchukuo, fiscal years 1943–44*

[In thousands of metric tons]

Consumer category	1943	Percent	1944	Percent
Military	26	3	21	2
Railroads	11	1	20	2
Industrial facilities	98	12	64	8
Civilian requirements			54	6
Iron pipes and tubes			39	5
Machinery			21	2
Reconstruction, dispersion			5	1
Steel-making [1]			22	3
Exports, low phosphorus [2]	124	15	238	29
Exports, other	558	69	347	42
Total	[3] 817	100	[3] 831	100

[1] Excluding pig iron for open hearth steel-making at Anshan. Such steel production was 837,000 tons in 1943 and 437,000 tons in 1944.
[2] Exported to Japan for Navy use.
[3] *Cf.* total production: 1943, 1,635,000 tons; 1944, 1,246,000 tons. Balance used for steel-making within the Anshan plant.

Source: Computed from data furnished by officials of Manchukuo Iron Mfg. Co. and the Iron & Steel Control association (Tekko Tosei Kai), November 1945.

APPENDIX TABLE 20.—*Production of ferro-alloy ores, Japan proper, fiscal years, 1931–45* [1]

[In metric tons]

Year	Chromium	Cobalt	Manganese	Molybdenum [4]	Nickel	Silicon	Tungsten
1931	9,727	.....	12,849	.....	.....	na	52
1932	12,492	.....	26,242	.....	.....	na	20
1933	19,997	.....	43,535	.....	.....	na	29
1934	27,222	.....	54,498	5,010	.....	na	65
1935	36,309	.....	69,349	6,435	.....	na	89
1936	39,253	.....	70,945	6,604	.....	na	56
1937	44,108	.....	83,007	4,065	.....	na	48
1938	49,001	.....	118,150	2,165	.....	na	179
1939	44,638	.....	130,000	3,000	.....	na	152
1940	53,550	.....	157,808	11,750	.....	na	677
1941	61,560	.....	195,546	49,408	.....	134,900	957
1942	60,989	.....	254,254	88,615	1,283	167,600	994
1943	64,280	120	342,884	176,196	2,504	179,000	856
1944	[3] 81,481	334	400,679	401,492	1,697	194,300	608
1945 [2]	[3] 16,570	315	67,017	90,831	369	na	82

na Indicates data not available.
[1] No phosphorus production. Only small amounts of titanium and vanadium were produced—from iron sands.
[2] First quarter.
[3] Data not complete; the above figures represent known production.
[4] Molybdenum figures in kilograms.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 18.—*Foundry pig-iron distribution in Japan proper, fiscal years 1937–45*

[In thousands of metric tons]

Consumer category	1937		1938		1939		1940		1941		1942		1943		1944		1945 [6]	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Army	138	16	164	16	177	16	184	14	259	20	219	18	152	12	122	12	12	12
Navy	163	19	195	19	210	19	193	15	296	23	278	23	216	17	86	8	12	12
Air Forces	[1]	.....	[1]	.....	[1]	.....	[1]	.....	[1]	.....	[1]	.....	[1]	.....	177	17	30	30
Merchant shipbuilding	112	13	133	13	144	13	77	8	77	6	165	14	318	21	[4] 230	21	[4] 6	6
Land transportation							59	4	60	5	49	4	78	6	45	4	8	8
Industrial facilities							326	26	284	22	215	18	302	23	334	31	25	25
Government							6	.....	5	.....	8	1	4	.....	.....	.....	.....	.....
Public works utilities and civilian goods	447	52	534	52	575	52	207	16	132	10	169	14	140	11	32	3	1	1
Exports "overseas territories" [1]							103	8	79	6	53	4	60	5	1	.....	.....	.....
Exports, other							111	9	69	5	40	3	34	3	14	1	.....	.....
Miscellaneous							.....	.....	[2] 43	3	[2] 22	2	[2] 8	1	[5] 27	3	6	6
Total	860	100	1,026	100	1,106	100	1,266	100	1,304	100	1,215	100	1,316	100	1,072	100	100	100

[1] Korea, Karafuto, Formosa, occupied "South Seas" territories.
[2] Included in "Army" and "Navy."
[3] "Emergency reserve."
[4] Includes iron for the new wooden shipbuilding program as follows: 1944, 37,970 tons; 1945, 1,700 tons.
[5] Includes 6,650 tons for air defense and 11,320 for "emergency reserve."
[6] First quarter only.

Source: Compiled from data supplied by Japan Iron & Steel Control association (Tekko Tosei Kai), November 1945. Figures for years 1937–42 are estimates based upon personal notebooks of employees of the association.

APPENDIX TABLE 21.—*Imports of ferro-alloy ores, concentrates, and metals by source and type, Japan proper, fiscal years 1931–4*

[In metric tons]

Year	Chromium	Cobalt			Manganese			Molybdenum				
	Philippines	Burma	Canada[1]	Total	India	Philippines	Total	Korea	Manchukun	United States	Total	
	Ore	Ore	Ore	Ore	Ore	Ore	Ore	Ore	Concentrates	Concentrates	Ore	Concentrates
1931		na		na	na		na					
1932		na		na								
1933		na		na								
1934		na		na								
1935		na		na	na		na					
1936		na		na	100,000		100,000					
1937		na		na	100,000		100,000			200		20
1938		na		na	100,000	5,700	105,700			500		50
1939	13,500	na	350	(350)	150,000	23,500	173,500			5,500		5,50
1940	37,300	na	400	(400)	120,000	5,700	125,700			4,000		4,00
1941	2,000	na		na	60,000	20,000	80,000		50			5
1942	40,000	na		na		20,000	20,000		700			70
1943	50,000	100		100		20,000	20,000	198	200		198	20
1944	20,000	100		100				155	900		155	90
1945[6]								25			25	

Year	Nickel[2]										
	Australia	Belgium	Canada	Celebes	China	France	Germany	Great Britain	Korea	New Caledonia	Norway
	Metal	Metal	Metal	Concentrates	Metal	Metal	Metal	Metal	Ore	Concentrates	Metal
1931	na	na				na	na	na			n
1932					120	100		1,100			
1933	5	7					5	1,600			
1934	340	na	300				10	1,250			75
1935			800			2		1,800		228	80
1936			400					1,050			40
1937			[3] 4,110					na			
1938			[3] 5,729					na			
1939			[3] 9,819							17,649	[3] 43
1940			[3] 458	10,432						19,363	n
1941				23,406						4,268	
1942				17,202							
1943				48,271							
1944				7,501							
1945[6]									1,211		

Year	Nickel (continued)					Titanium			Vanadium				
	United States	Other		Total		Straits Settlements	Thailand	Total	Manchukuo	Peru	United States	Total	
	Metal	Metal	Ore	Concentrates	Metal	Ore	Ore	Ore	Ore	Ore	Concentrates[5]	Ore	Concentrate
1931	157				(157)								
1932	150				1,470								
1933	37				1,654								
1934					(2,650)								
1935	350			228	3,752								
1936	156				2,006								
1937		[3] 1,432			[3] (21,522)						[4] 100		10
1938										150	[4] 200	150	20
1939				17,649						500	[4] 1,500	500	1,50
1940				29,795	[3] (458)					500	[4] 800	500	80
1941				27,674			1,000	1,000		na		na	
1942				17,202		1,000	2,000	3,000		na		na	
1943				48,271		2,000	[4] 2,800	4,800					
1944				7,501					200			200	
1945[6]			1,211										

See end of table for footnotes.

APPENDIX TABLE 21.—*Imports of ferro-alloy ores, concentrates, and metals by source and type, Japan proper, fiscal years 1931–45*—Continued

[In metric tons]

Year	Tungsten											
	Burma	China	Great Britain	Hong Kong	India	Korea	South America	Straits Settlements		Thailand	Total	
	Concentrates	Concentrates	Concentrates	Concentrates	Concentrates	Ore	Concentrates	Ore	Concentrates	Concentrates	Ore	Concentrates
931												
932												
933												
934												
935												
936								30			30	
937												
938			[4] 600		200							800
939			[4] 1,000				1,000					2,000
940		[4] 100	[4] 1,200				1,000			200		2,500
941		[4] 150	200	450			1,200			1,000		3,000
942	1,000	[4] 500		500					200	1,200		3,400
943	1,500	400		450		1,069			400	800	1,069	3,550
944	500	400		400		77		200		400	277	1,700
945[6]		400										400

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.
"Ore" Crude ore.
"Con" Concentrate.
"Met" Metallic form.

[1] 30 per cent cobalt.
[2] Crude ores contained 0.6–1.4 per cent nickel; concentrates, 3.26–4.34 per cent nickel; metallic nickel, 98–99 per cent nickel.
[3] Calendar year.
[4] Estimate.
[5] Included some ores in 1939 and 1940.
[6] First quarter.

Source: Compiled from figures collected by the Bureau of Mines, Ministry of Commerce and Industry, from the Finance Ministry, the Mitsubishi Economic Research Bureau, the Mitsubishi Trading company, and the Mitsui Products company, October–November, 1945.

APPENDIX TABLE 22.—*Production of ferro-alloys, Japan proper, fiscal years 1931–45*

[In metric tons]

Year	Ferro-manganese	Ferro-silicon-manganese	Ferro-silicon	Ferro-chromium	Ferro-tungsten	Ferro-molybdenum	Ferro-vanadium	Ferro-titanium	Ferro-phosphorous
931	10,637		4,103	218	32	21			na
932	17,985		4,883	1,126	59	85			na
933	23,026		7,622	1,480	26	286			na
934	29,364		11,726	2,280	232	132			na
935	34,710		15,571	4,078	272	188			na
936	34,922	3,774	15,313	6,424	447	199		13	na
937	54,080	4,352	11,632	8,597	804	285	31	25	na
938	66,927	3,377	20,513	15,141	1,479	672	45	46	na
939	61,456	6,286	30,035	13,966	2,499	1,415	578	160	na
940	70,728	10,440	36,877	14,716	3,274	1,802	708	213	2,745
941	51,323	17,230	33,388	21,222	2,949	988	832	125	1,376
942	71,354	16,855	25,741	21,664	2,152	546	533	117	1,547
943									
I	18,903	2,698	8,584	10,725	1,012	69	89	49	363
II	15,843	1,516	6,521	7,440	853	89	84	75	274
III	12,481	2,376	6,068	8,129	755	103	95	71	374
IV	8,056	1,274	2,318	5,538	596	104	54	48	146
Total	55,283	7,864	23,491	31,832	3,216	365	322	243	1,157
944									
I	14,444	3,610	8,541	6,240	650	118	51	69	354
II	12,257	3,407	8,044	5,451	481	72	97	74	168
III	11,757	2,893	9,114	5,828	274	70	52	66	248
IV	6,075	2,745	4,879	2,479	162	77	24	69	207
Total	44,533	12,655	30,578	19,998	1,567	337	224	278	977
945									
I and II	15,634		4,551	4,273	58	65	57	31	na

na Indicates data not available.

Source: Data compiled by Iron and Steel Control association (Tekko Tosei Kai) and Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 23.—*Production of ferro-alloys, Korea, Manchukuo, and Formosa, fiscal years 1931–45*

[In metric tons]

Year	Korea					Manchukuo					Formosa	
	Ferro-tungsten	Ferro-manganese	Ferro-silicon	Ferro-molybdenum	Ferro-chromium	Ferro-manganese	Ferro-silicon	Ferro-tungsten	Ferro-chromium	Ferro-molybdenum	Ferro-silicon	Ferro-manganese
1931												
1932												
1933												
1934												
1935						429	27					
1936						1,844	262					
1937						1,127	303					
1938	19			425		4,078	448					
1939	1,080		522	35	8	3,933	368					
1940	1,449		2	28	97	4,561	332	69		9	3,780	1,969
1941	1,900	56	111	38	289	7,382	381				3,902	3,40
1942	2,010	180	1,165	27	329	7,389	434	69	87	6		
1943	3,436	1,233	1,159	186	150	na	na	na	na	na	4,752	1,38
1944	4,321	2,979	2,320	232	99	na	na	na	na	na	4,350	1,230
1945[1]	na	na	na	na	na	na	na	na	na	na	960	

na Indicates data not available.

[1] First quarter.

Source: Compiled by Iron and Steel Control association (Tekko Tosei Kai) from data of the Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 24.—*Imports of ferro-alloys, Japan proper, fiscal years 1935–44* [1]

[In metric tons]

Year	ferro-silicon	Ferro-manganese	Ferro-tungsten	Ferro-molybdenum
1935	2	na		
1936	na	na		
1937	na	na		
1938	na	na	226	54
1939	na	na		
1940	3,780	1,969		3
1941	3,902	3,401		
1942				
1943	4,752	1,389		
1944	3,810	1,230		

na Indicates data not available.

[1] No data on the imports of ferro-alloys from Korea were available. It is known that there were some imports of ferro-tungsten, ferro-molybdenum, and ferro-phosphorous from Korea. The breakdown of imports by countries was not available.

Source: Compiled by Bureau of Mines, Ministry of Commerce and Industry, and by Iron and Steel Control association (Tekko Tosei Kai), October–November 1945.

APPENDIX TABLE 25.—*Exports of ferro-alloys, Japan proper, fiscal years 1935–44*

[In metric tons]

Year	Ferro-manganese	Ferro-silicon	Ferro-chromium	Ferro-phosphorous
1935	2,954	2,224	1,159	500
1936	4,216	2,563	1,554	800
1937	9,066	5,513	2,400	1,611
1938	1,702	849	150	
1939	720	260	1	
1940	1,035	420	65	
1941	1,040	304	65	
1942	1,800	940	250	
1943	848		57	
1944	480		30	

Source: Compiled by Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 26.—*Production of finished special steel (alloy and high carbon) by type of plant, Japan proper, fiscal years 1931–45*

[In thousands of metric tons]

Year	Civilian plants			Military arsenals					All plants		
				Army [2]	Navy [4]			Total Army & Navy			
	Alloy	High carbon	Total	Alloy	Alloy	High carbon	Total		Alloy	High carbon	Total
1931	na	na	14	([3])	na	na	na	na	na	na	(14)
1932	na	na	28	([3])	na	na	na	na	na	na	(28)
1933	na	na	50	([3])	na	na	na	na	na	na	(50)
1934	na	na	58	1	na	na	na	na	na	na	(58)
1935	na	na	69	1	na	na	34	35	na	na	104
1936	na	na	85	1	na	na	38	39	na	na	124
1937	na	na	155	2	na	na	55	57	na	na	212
1938	206	51	257	2	na	na	69	71	(208)	(51)	328
1939	272	117	389	2	57	15	72	74	331	132	463
1940	252	110	362	4	64	17	81	85	320	127	447
1941	276	120	396	7	77	20	97	104	360	140	500
1942	337	198	535	11	84	21	105	116	432	219	651
1943	435	320	755	16	123	35	158	174	574	355	929
1944	478	515	993	13	135	44	179	192	626	559	1,185
1945 [1]	na	na	150	3	9	4	13	16	na	na	166

na Indicates data not available.

( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] First quarter. [2] No high carbon steel produced. [3] Less than 500 tons. [4] Estimated.

Source: Civilian data compiled by Iron and Steel Control association (Tekko Tosei Kai); military data computed from War and Navy Departments' estimates, November 1945.

APPENDIX TABLE 27.—*Production of finished alloy steel in civilian plants by process, Japan proper, fiscal years 1940–44* [1]

[In thousands of metric tons]

Year	Alloy				High carbon	Total	
	Cast	Forged	Rolled	Total		Amount	Percent alloy steel
1940	25	125	102	252	110	362	69.6
1941	34	143	99	276	120	396	69.7
1942	36	181	120	337	198	535	63.0
1943							
I	9	45	48	102	60	162	63.0
II	9	45	42	96	60	156	61.5
III	8	50	51	109	80	189	57.7
IV	10	45	73	128	120	248	51.6
Total	36	185	214	435	320	755	57.6
1944							
I	10	50	70	130	138	268	48.5
II	10	50	70	130	126	256	50.8
III	10	45	65	120	139	259	46.3
IV	8	40	50	98	112	210	46.7
Total	38	185	255	478	515	993	48.1

[1] Excludes Army and Navy arsenals.

Source: Estimated by Iron and Steel Control association (Tekko Tosei Kai), November 1945.

APPENDIX TABLE 28.—*Ratio of coke consumed to pig-iron output in selected Japanese iron and steel plants*

Company	Location	1 October 1941–31 March 1942	1 October 1944–31 March 1945
Japan Iron Mfg. Co.	Yawata, Kyushu	1.0	1.3
Japan Iron Mfg. Co.	Wanishi, Hokkaido	1.2	1.3
Japan Iron Mfg. Co.	Kamaishi, Honshu	1.0	1.2
Japan Iron Mfg. Co.	Hirohata, Honshu	1.2	1.2
Japan Steel Tube Co.	Kawasaki, Honshu	1.3	1.4
Japan Steel Tube Co.	Tsurumi, Honshu	1.3	1.5

Source: Compiled from reports by individual companies to USSBS, November 1945.

APPENDIX TABLE 29.—*Pig iron, open hearth and basic bessemer ingot steel, and rolled-steel products production, by months, Japan proper, April 1942–June 1945*

[In metric tons]

Year and month	Pig iron	Open hearth and basic bessemer ingot steel	Rolled-steel products
1942			
April	349,936		316,905
May	363,004	1,391,000	357,810
June	344,162		358,386
July	352,846		299,486
August	347,250	1,261,000	291,658
September	348,960		330,815
October	356,712		327,195
November	327,609	1,499,000	325,870
December	368,708		367,660
1943			
January	391,845		365,908
February	359,009	1,528,000	345,869
March	399,250		364,290
Total	4,306,291	5,679,000	4,051,792
April	324,004	469,120	364,458
May	337,951	499,014	363,003
June	309,111	487,012	339,592
July	300,055	494,023	324,016
August	305,536	449,216	323,604
September	308,475	444,907	335,429
October	328,126	497,014	318,677
November	321,381	499,806	335,481
December	328,493	521,200	364,868
1944			
January	323,060	525,285	360,829
February	300,466	486,149	359,899
March	326,468	514,583	359,444
Total	3,813,126	5,887,329	4,149,210
April	315,169	471,481	330,907
May	310,702	474,774	345,771
June	291,193	419,834	293,395
July	264,290	382,308	249,555
August	198,559	297,258	185,396
September	201,150	305,585	184,072
October	224,187	334,793	213,239
November	201,778	325,733	209,672
December	212,076	316,578	196,095
1945			
January	188,972	281,068	174,672
February	155,393	232,312	126,175
March	149,650	210,642	123,317
Total	2,713,119	4,052,266	2,632,266
April	125,899	198,537	106,501
May	113,330	176,167	78,682
June	100,781	157,368	71,830

Source: Computed from a sample ranging from 98 per cent to 83 per cent of total pig iron production, 81 per cent to 70 per cent of total open hearth and basic bessemer ingot steel production, and 93 per cent to 73 per cent of total rolled products production. Information obtained from reports submitted by the Iron and Steel Control association (Tekko Tosei Kai) and by individual iron and steel companies in compliance with USSBS Basic Materials Division long-form questionnaire, October 1945.

PART III

LIGHT AND NON-FERROUS METALS

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ALUMINUM

I

INTRODUCTION

The importance of the aluminum industry lies in its absolute indispensability for the production of aircraft. During wartime, as in peacetime, it finds a variety of other uses in suitable alloys where lightness of weight combined with strength, resistance to corrosion, or electrical conductivity are desirable qualities. When its supply is threatened, however, practically all uses other than in aircraft find available substitutes. During the final year of the war with Japan, when almost all aluminum was being delivered to aircraft channels, aluminum was unique as a basic material in that it had a single-end use with virtually no available substitutes. Strategically, therefore, the aluminum industry may be considered an integral stage in the process of producing aircraft. Evaluation of Japanese planning of the scale and rate of expansion of aluminum output—as well as evaluation of the target priority of the industry for Allied air attack—must, therefore, be considered in the light of the scale, rate of expansion, and target importance of the general aircraft production system.

II

DEVELOPMENT OF THE JAPANESE ALUMINUM INDUSTRY BEFORE THE WAR

1. *Experiments with domestic resources*

The aluminum industry, in contrast to most other non-ferrous industries in Japan, is of very recent origin, all plants having been constructed within 8 years of the beginning of the war with the United States. In 1933 the first two entrants into the field, the Showa and Sumitomo interests, began by exploiting "domestic" sources of alumina, depending chiefly on alunite imported from southern Korea. By 1936 four plants were in operation producing alumina (Aluminum-oxide) from such sources, together with four reduction plants for the production of virgin aluminum (Table 1).

TABLE 1.—*Alumina and aluminum capacity in Japan proper, Korea, and Formosa, fiscal years 1935–45* [1]

[In metric tons]

Year	Alumina capacity	Number of alumina plants	Aluminum capacity	Number of reduction plants
1935	21,400	3	13,000	3
1936	24,900	4	21,000	4
1937	42,900	6	26,000	5
1938	73,400	6	34,000	5
1939	84,900	7	37,600	6
1940	132,400	9	57,600	9
1941	229,100	11	111,200	11
1942	313,700	12	132,400	11
1943	360,700	12	171,600	14
1944	398,700	15	159,100	12
1945 [2]	419,300	15	159,100	12

[1] Data pertain to end of year.
[2] As of June 1945.

Sources: Appendix Tables 4 and 5.

The early attempts at use of materials close at hand, though highly publicized by the Japanese, were of limited success. The quality of refined aluminum was inferior, and costs were high. The main Japanese effort after 1935, therefore, was diverted to the construction of plants to use the superior raw materials which could be obtained from the southern areas, notably bauxite from the Netherlands East Indies and Malaya. But the Japanese never relinquished the goal of founding this basic war industry on raw materials within areas closer to the heart of the empire. A number of relatively small alumina plants were constructed in Japan proper, and continued to attempt a variety of processes in the utilization of alunite, clay, and aluminous shale throughout the war. Such plants in Japan proper produced an average of approximately 9,000 tons [1] of alumina per year until 1944 (Appendix Table 6). Total nonbauxitic alumina production in relation to total alumina production is indicated in Table 2.

[1] Metric tons are used throughout. Years, unless otherwise specified, are fiscal.

TABLE 2.—*Summary of alumina and aluminum production in Japan proper, Korea, and Formosa, fiscal years 1933–45*

[In metric tons]

Year	Production of alumina			Production of aluminum ingot
	From bauxite	From other than bauxite [1]	Total alumina	
1933	----------	100	100	19
1934	----------	2,424	2,424	1,002
1935	----------	7,434	7,434	3,166
1936	----------	13,167	13,167	5,707
1937	24,316	7,181	31,497	13,979
1938	38,656	9,618	48,274	20,736
1939	53,956	11,240	65,196	29,559
1940	81,837	15,650	97,487	40,863
1941	136,837	15,046	151,883	71,740
1942	212,558	13,623	226,181	103,075
1943	304,734	13,757	318,491	141,084
1944	190,585	34,626	225,211	110,398
1945 [2]	1,621	14,598	16,219	6,647

[1] Includes production from aluminous shale, alum-clay, alunite, and scrap.
[2] First quarter.

Source: Appendix Table 3.

2. *Construction of Bayer-process plants in Formosa and Japan*

In 1935 the Japan Aluminum Co., to take advantage of surplus electric power available in Formosa and to economize on the shipping of the bulky raw materials all the way to Japan, began construction of a 12,000 ton Bayer-process alumina plant, with related aluminum reduction facilities for 6,000 tons, at Takao. The capacity of the alumina plant was doubled by 1940, and almost tripled by early 1942. Reduction facilities at Takao were also expanded, and a new plant at Karenko, on the east coast of the island, was constructed to provide a corresponding increase in Formosan aluminum capacity. This early construction in Formosa was shortly followed by conversion of major existing plants, and construction of similar plants using the more facile and less costly Bayer process in Japan proper. After 1937, when alumina was first produced from bauxite, alumina and aluminum production expanded rapidly (Table 2). By 1940, 94,000 tons of alumina were being produced in Japan proper and Formosa, of which 87 percent was from bauxite (Appendix Tables 3 and 6).

3. *Continental Construction*

In addition to the facilities noted above in Japan proper and Formosa, Japanese plans envisioned founding a substantial aluminum industry in Korea and the newly acquired area of Manchukuo. Three integrated alumina-aluminum plants were erected on the continent and were in operation before the war, providing a combined capacity of approximately 30,000 tons of alumina and 17,000 tons of aluminum. All were designed to utilize Manchukuoan aluminous shale and to take advantage of ample available supplies of electric power. The plant at Fushun, Fengtien Province, largest of the three and the only plant in Manchukuo, was begun in 1937 and completed the following year. It had a capacity of 10,000 tons of alumina and 5,000 tons of aluminum. Duplication of these units doubled its capacity by 1940. An electric furnace process substantially similar to the well-known Pedersen process was used. The remaining two plants, located in Korea at Chinnampo (Heiannando) and Konan (Kankyonando), provided a capacity of 9,000 tons of alumina and 7,500 tons of aluminum by 1941. The former used an alumina process similar to that at Fushun; the latter used a soda-lime-sinter process which is of particular significance because its measure of success with the method was instrumental in shaping Japanese plans for conversion of the whole industry during the late phases of the war.

III

THE JAPANESE ALUMINUM POSITION AT THE BEGINNING OF THE WAR

1. *Production and capacity*

In December 1941 the Japanese were producing aluminum in Japan proper, Korea and Formosa at the rate of 70,000 tons per year, of this 90 percent was derived from bauxite, which, in turn, was obtained chiefly from Bintan Island, N.E.I., with lesser amounts from Malaya, Palau and Indo-China. Alumina capacity in Japan proper, Korea and Formosa was 195,000 tons; aluminum capacity 170,000 tons. Additional aluminum production of about 8,000 tons, alumina capacity of 20,000 tons and aluminum capacity of 10,000 tons, as noted above, were available in Manchukuo.

2. *Bauxite position*

At the time of the attack on Pearl Harbor, the Japanese stock of bauxite was about 250,000 tons (Appendix Table 16), an amount sufficient for slightly less than 9 months' supply at the then current rate of utilization. In the light of the actual realized increase in the rate of aluminum production necessitated by rising aircraft requirements, this

bauxite supply was sufficient for less than 7 months.

While a rate of aluminum supply of 70,000 tons does not appear sizable in terms of the requirements of modern war, it was sufficient for existing Japanese rates of plane production. Planned expansion of aircraft production, however, required a corresponding, but somewhat preceding, expansion of aluminum output. Such expanded production could not long be maintained without securing quickly the sources of bauxite in the southern areas. The critical weakness in the Japanese aluminum position at the beginning of the war, therefore, was the threat of not acquiring in time assured access to those areas for the supply of her vital bauxite requirements.

IV

INTRODUCTION AND DEVELOPMENT OF WARTIME CONTROLS

1. *Control organizations and functions*

With the opening of the war the development of government controls over the aluminum industry followed closely the pattern in related industries. The particularly close relation of aluminum and magnesium to the aircraft industry made both these metals of special interest. In the field of control by governmental and quasi-governmental bodies, therefore, they were administered by organizations devoted specifically to the light metals. During the first 2 years of the war, general over-all planning of the light metals production and distribution program was established within the Cabinet Planning Board. Administration of the established program at the government level was performed by the Light Metals bureau of the Ministry of Commerce and Industry. As an intermediary between the government and operating companies, there was established a quasi-governmental body, the Light Metals Control Association (KEIKINZOKU TOSEI KAI), composed of representatives of all producers in the field. Originally operating as a voluntary association of principal producers, membership was made mandatory and powers made explicit in September 1942. The organization became the agency for immediate control over such matters as production quotas, standardization and rationalization, dissemination of technical information, allocation of construction and maintenance materials, and forecasts of future production. Since the organization was not sanctioned by law to perform market functions, the Imperial Light Metals Control Co. (TEIKOKU KEIKINZOKU TOSEI KABUSHIKI KAISHA) was established as a subsidiary. The latter functioned primarily as a purchase and sales organization for channelling aluminum and magnesium production into allocation categories and as an instrument for governmental subsidies. Early in the war the company bought aluminum ingot at the calculated costs of production of individual firms and, in turn, sold it at the average of these costs to companies presenting purchase certificates—chiefly fabricators. Later, however, costs rose so rapidly that subsidies were resorted to in the form of sale of aluminum ingot (on a sliding scale based on quality) at prices below costs, the government making up the difference.

2. *Control of secondary aluminum*

Secondary aluminum production from "new" and "old" scrap was routed through different channels. Directly usable "old" scrap, after collection and remelting, was purchased by the Imperial Light Metals Control Co. and distributed by allocation certificate to authorized consumers. "New" scrap, that is, cutting and processing wastage, largely within the aircraft industry, was collected and returned to the three major fabricating companies: Sumitomo, Furukawa and Kobe Steel—for rechannelling within the industry. This large segment of total supply (the loss ratio in processing fabricated shapes was estimated to be as high as 45 per cent) was not subject to direct allocation control, though some effort was made late in the war to take into account the flow of such metal in distributing primary aluminum. As will be noted below, when the supply of primary ingot declined precipitously toward the end of 1944 (Appendix Table 9), processing wastage became the chief source of aluminum for the aircraft pipeline. The lack of control together with the secrecy with which quantative data on this important supply category was held by Army and Navy authorities make difficult any exact statistical measure of contribution to supply. Indeed, officials of the government in charge of planning and control of aluminum have insisted on the extent to which they, themselves, were not informed on the magnitude of this supply component—a factor which admittedly vitiated effective over-all planning. There is some testimony that despite the appearance of complete mobilization toward the end of the war of aluminum

for aircraft use in official distribution data (Table 4), substantial quantities of metal were allowed to leak out of fabricating plants into a variety of prohibited uses.

3. *Control of allocations to aircraft*

Throughout the first two years of the war aircraft production for the separate branches of the armed forces was controlled individually by each branch. Aircraft requirements for light metals were included, therefore, in allotments to the Army and Navy, and sub-allotted in turn by those agencies to producers of aircraft. In November of 1943, with the establishment of the Munitions Ministry for better coordination of the productive effort and more vigorous prosecution of the war, a separate department was set up within the Ministry—the Air Ordnance Bureau (KOKU HEIKI SOKYOKU)—for the joint planning and administration of aircraft production. Within the Bureau the Light Metals Section of the Materials Branch took over direct control of allocation of light metals within the newly established "D" category.

V

THE PERIOD OF WARTIME EXPANSION (DECEMBER 1941–MAY 1944)

1. *Expansion of plant capacity*

With the opening of hostilities, expansion of the aluminum industry, begun before the war, continued to be pressed vigorously to provide for the expanding requirements of aircraft production. By constructing additional plants and expanding almost all existing facilities, alumina capacity in Japan proper, Korea and Formosa was increased from 195,000 tons per year at the outbreak of the war to 373,000 tons in June 1944. By June 1945 capacity had reached 419,000 tons, or more than double the figure at the beginning of the war. Aluminum reduction capacity was similarly expanded; from 107,000 tons of aluminum per year in December 1941, capacity reached 183,000 tons by June 1944. After that, damage to the two Formosa plants reduced capacity to 160,000 tons shortly before the surrender. The lack of balance between alumina and aluminum reduction capacity before the end of the war (it requires roughly two tons of alumina for one ton of aluminum) is accounted for by the inclusion in alumina capacity of both converted shale-processing capacity and capacity of remaining Bayer-process equipment, while in some instances reduction facilities already begun were not completed due to the failure of alumina supply. Capacity data for alumina and aluminum plants are presented in Table 1 and, in detail, in Appendix Tables 4 and 5.

2. *Expansion of bauxite imports*

The increased processing capacity was accompanied by corresponding efforts to obtain the necessary bauxite supplies. As a result of the British-Dutch partial embargo on raw material exports to Japan proper, Japanese imports of bauxite had fallen to 147,000 tons in 1941, the lowest point since 1937 (Table 3). Japanese subjugation of the southern area was rapid enough, however, so that bauxite imports could be expanded to 450,000 tons during 1942, a quantity in excess of that for any previous year. Imports were further increased in 1943 to a total of 820,000 tons. As much as 115,000 tons were imported in the single peak month of December, and bauxite stocks regained for the first time their level at the beginning of the war.

TABLE 3.—*Imports and stocks of bauxite and aluminous shale in Japan proper, Korea, and Formosa, fiscal years 1935–45*

[In metric tons]

Year	Bauxite		Aluminous shale	
	Imports[1]	Stocks[2]	Imports	Stocks[2]
1935			3,690	na
1936	24,762	na	8,360	na
1937	101,149	na	21,750	na
1938	220,478	na	26,750	na
1939	352,458	na	35,990	na
1940	280,189	na	51,710	na
1941	146,711	191,174	44,965	6,520
1942	450,134	209,607	47,358	14,855
1943	820,534	288,471	50,499	20,692
1944				
I	141,470	176,241	48,878	36,109
II	135,778	36,196	27,063	37,664
III	29,955	2,651	28,222	32,061
IV	40,132	5,233	43,248	38,767
Total	347,335		147,411	
1945				
I	1,800		37,614	55,168

na Indicates data not available.

[1] In terms of wet weight, 1935–41; dry weight, 1942–45.
[2] Stocks pertain to end of period.

Sources: Appendix Tables 13, 14, 15, and 16.

3. *Planned and actual production*

Quarterly mobilization plans for aluminum production added up to 116,000 tons in 1942, but rose

rapidly to total 152,000 tons in 1943, with a planned rate during the last quarter of 170,000 tons (Table 4 and Appendix Table 18). Available information on such plans indicates that they can be considered neither as anticipated absolute requirements for aluminum, nor as preliminary goals for desired production, but rather as planned screened allocations of quantities actually expected to be forthcoming for the pertinent period, estimated at its beginning. Estimates were made for a period of a year through 1943 (though broken down by quarters), but were reestimated by quarter thereafter. Quantities included under planned allocations comprised production within Japan proper, Korea and Formosa plus receipts from Manchukuo. The unexported portion of Manchukuoan production (roughly half) provided aluminum for the Kwantung Army (about 2,400 tons per year) and for other uses, chiefly electrical, as determined by the Manchukuoan government. While realized production in Japan proper, Korea and Formosa, plus imports from Manchukuo, in 1942 totaled 105,000 tons, about 90 per cent of the plan, new supply followed planned quantities more closely in 1943, reaching 144,000 tons, or 95 per cent of the goal (Appendix Table 3). At the peak of May 1944, plants in Japan proper, Korea and Formosa reached an annual rate of aluminum production of 180,000 tons, or very close to maximum capacity (Appendix Table 9). An additional 8,000 tons was being produced in Manchukuo (Appendix Table 10).

4. *Distribution of aluminum*

Quarterly allotments of primary aluminum to allocation categories under the distribution program of the Imperial Light Metals Control company are presented in Appendix Table 19. Distribution of secondary aluminum ("old" scrap only) is presented in Appendix Table 20. It should be noted that the former are not actual distribution data, but the authorized pattern of the distributing organization. Since the totals of such allotments approximate fairly closely the total available new supply of primary aluminum, and since such actual distribution data as are available are in close relation to allotted quantities, particularly for aircraft, the allotment program may be considered a fair indication of actual distribution.

During this period of rising production, the general supply of aluminum, despite expanding aircraft requirements, was relatively easy. In 1942, of total allotments of primary ingot, only 61 per cent was to be channelled into aircraft uses, as indicated in Table 4.

TABLE 4.—*Planned total new supply and allotment of primary aluminum to allocation categories, fiscal years 1942–45*

[In metric tons]

Year	Planned total supply [1]	Total allotment [2]	Allotment to allocation categories [2] (per cent)			
			Aircraft	Army	Navy	Indirect military and civil
1942	116,370	108,726	60.9	13.7	5.4	20.0
1943	152,050	145,438	72.4	7.8	4.8	15.0
1944	133,440	112,511	89.0	3.2	3.3	4.5
1945 [3]	16,000	10,200	100.0			

[1] Mobilization plan for total allocations.
[2] Distribution program of Imperial Light Metals Control company (Teikoku Keikinzoku Tosei Kabushiki Kaisha).
[3] First quarter.

Sources: Appendix Tables 18 and 19.

In 1943, though there was realization in government circles that Japan's shipping position, and consequently the prospect for bauxite imports, was fast deteriorating, the quantity devoted to aircraft was only 72 per cent. As late as the January-March 1944 quarter, as much as 17 per cent of primary ingot was destined for other than aircraft uses. In addition, significant quantities of remelted "old" scrap flowed into non-aircraft channels. This factor, together with leakages of aluminum into prohibited uses from certain segments of the industry as noted above, suggest that the apparent data overstate the percentage flow to aircraft.

During this period aluminum was substituted for copper in a number of aircraft and electrical uses. As much as 20 per cent of copper required for wire, and 90 per cent of copper in airframes was replaced by aluminum.

VI

THE INDUSTRY AFTER FAILURE OF BAUXITE SUPPLIES

1. *The decline of bauxite imports and stocks*

The decline of bauxite imports resulting from shipping attrition and consequent depletion of stocks is set forth in Table 3, and more fully in Appendix Tables 14 and 15. It is evident that until the end of 1943 the Japanese were able to import enough bauxite into Japan proper to maintain fairly consistent stocks, despite the rising rate of utilization in

expanding aluminum production. By the end of June 1944, however, the situation was deteriorating rapidly. Although stocks of 176,000 tons still existed, they were being exhausted, having been depleted by 120,000 tons in the preceding two quarters. As a result of special efforts to mobilize all possible shipping to support the bauxite position, partial success was attained in August, when more than 90,000 tons were imported, but only 20 per cent of this quantity arrived in September. After the invasion of the Philippines bauxite imports were sporadic, and stocks of any appreciable magnitude disappeared after October.

2. *Utilization of alternative aluminous materials*

a. *Delay in conversion plans.* Very early in the war the Japanese were aware of the precarious position of their aluminum industry, based as it was on the maintenance of the long supply lines to the south. The need for steps toward securing adequate capacity based on materials within the Inner Zone was pressed in many quarters. But, as pointed out by Chief Director Yoshida, Ichiio of the Light Metals Control association, "the very favorable turn of events at the beginning of war made all Army, Navy, government authorities and business circles intoxicated with great joy, so that all of them were forgetful of the process-conversion problems in the summer of 1942."

b. *The plan for conversion to aluminous shale.* By December 1942, however, a committee composed of industrial and research specialists was appointed by the prime minister to investigate Japan's aluminum position. In its report of July 1943, pointing up the danger of Japan's current position, the committee recommended the following: (1) the expansion of aluminous shale production facilities in North China; (2) complete conversion of existing Bayer plants to the use of the aluminous materials from North China and Japan; (3) expansion of continental production by construction of new plants and transfer of plants from Japan; and (4) the use of converted cement plants in Japan for production of aluminous clinker, in turn to be processed by alumina plants. Except for beginning construction at Changtien (Shantung Province, North China) of a 20,000 ton alumina plant (but never put into operation), no steps were taken for actual conversion in Japan until late in 1943. At that time an attempt at large-scale conversion was begun, following the general pattern of the above recommendations. By February 1945 converted alumina capacity of 335,000 tons was expected in Japan proper, supplemented by over 100,000 tons on the continent. It appears definitely established, however, that the government had delayed taking concrete steps until too late.

c. *Production, imports, and stocks of shale.* The North China shale-producing areas were developed to produce adequate quantities of shale, but large quantities were left stocked at the mines, rail heads and harbors, owing to the shipping shortage and inadequate handling facilities at Tsingtao and Chinwangtao. In 1944, 147,000 tons were imported into Japan proper and Korea, a sizeable increase over previous levels (Table 3), but entirely inadequate to compensate for the decline in bauxite supplies, particularly in view of Japanese technical difficulties and high rate of utilization per unit of output. Aluminous shale imports continued through May 1945 at about the same rate, after which shipping losses effectively deprived Japan of even this source of supply. By August 1945 stocks of aluminous shale in Japan were relatively unimportant (Appendix Table 16).

d. *Conversion of Bayer plants.* The physical conversion of Bayer plants, however, required a much longer period than had been contemplated. Difficulties were encountered in shortages of construction materials, machinery, and labor supply. Moreover since the order for conversion was not accompanied by financial aid in absorbing the necessary costs, not in government-financed construction, there appeared to be considerable inertia and even opposition to the plan by industry officials because of the greater difficulty and higher costs in the necessary processes. Three cement plants were converted to use their heavy crushing equipment and rotary kilns in the production of "clinker".

The delay in conversion, accompanied by falling aluminum production, suggested a method of desperation to the Japanese planners. Aluminous shale was to be electrolyzed directly in aluminum reduction plants, producing a low-grade metal of 70–80 per cent aluminum. The crude product, as well as various types of scrap aluminum, or "dross", was then to be put through the normal Bayer process, appearing as alumina, and finally electrolyzed again to produce virgin ingot. That cumbersome and wasteful process was put into effect and was continued in 1945, in part to economize on the use of soda ash. While aluminum produced in this manner was found satisfactory, the method was highly wasteful of synthetic cryolite and used huge quantities of electric power. In total, about 6,000 tons of crude metal were produced in the first stage of the process (Appendix Table 11).

e. *Technical difficulties in operation.* Adding to the problems of physical conversion, which were delayed, as noted above, by governmental and industrial inertia, and hindered in execution by a variety of shortages, further delays were encountered in reaching desired rates of output because of unforeseen technical difficulties. The lime-soda process had been chosen as the standard means for extracting alumina from shale (a variety of other processes indicated in Appendix Table 6 were used on lesser scales in processing both shale and local alunite) largely because of the success of the process at the Konan plant of the Korea Light Metals company and the possibility of minimizing constructional problems through employing equipment of cement plants. No time was available for experiment with other processes or extensive trial in pilot plants. While the alumina content of shale, 50–58 percent, was as high as that of bauxite, its silica content, averaging 17–20 percent and more, was about three times as high. Typical analysis data on the composition of aluminous shale and the resulting aluminous clinker are presented in Appendix Table 17. In practice, the high silica content of the shale resulted in difficulties of separation and handling which were never fully worked out. Japanese technical experts expressed the opinion that, while the process was suitable where highly capable technical experts were available to establish and maintain controls, it could not be handled adequately by the staff actually responsible for its establishment. In due time it was believed the difficulties could be overcome, but conversion was begun too late.

f. *Consumption of limited resources.* Not only was there a delay in achieving a satisfactory scale of output, but the production actually accomplished was wasteful of the highly limited resources. In Table 5 a comparison is provided between actual raw materials used and quantities which the Japanese Industrial Research Laboratory expected that Japanese industry, under industrial conditions, would require per ton of alumina.

TABLE 5.—*Comparison between expected and actual consumption of raw materials in alumina production, per ton of alumina*

Material	JIRL expectations	Actual use
Aluminous shale	2.3 tons	4 tons
Clinker	4 tons	6+tons
Soda ash	260 kg	800 kg
Limestone	850 kg	950 kg

Source: Light Metals Control association (Keikinzoku Tosei Kai), November 1945.

The "actual use" data in Table 5 were derived from operations which had been considered to have reached a stage of "efficiency." In earlier operations use of 6–8 tons of aluminous shale was not uncommon. Such excessive rates of utilization of materials are particularly significant where, as in the Japanese situation, basic raw materials such as aluminous shale and soda ash were critically short. From given supplies of shale the aluminum derived was only 58 percent of that technically possible; or conversely, to produce given quantities of aluminum, 74 percent more shale and 208 percent more soda ash were required than under conditions of expected efficiency.

g. *Effects of other shortages.* Besides the major factors noted above, relating to bauxite and aluminous shale, other shortages affected production in varying degrees. Analysis of plant data indicates a particular shortage of soda ash and severely limited supplies of pitch coke. But in the period close to the end of the war the major shortage was coal. Electric power was usually adequate because of the high priority provided the aluminum industry.

The quantity of soda ash gradually decreased throughout the war because of the difficulty of importing salt. Its supply became critical to the aluminum industry by the middle of 1944, and quantities made available continued to decrease to the end of hostilities. The supply of caustic soda naturally followed a parallel course. The pitch coke shortage necessitated a resort to materials of lesser purity for carbon electrodes, which resulted in decreasing purity of product. Yet this problem was considered of less importance than that of coal or soda. The problem of labor appeared to be of secondary importance in the industry, since its requirements were largely for unskilled workers, with a total manpower requirement of not more than 45,000 during peak operations.

The influence of shortages of these secondary factors was overshadowed and mitigated by the primary limit to production imposed by the supply of basic aluminum-bearing materials. But shortages of soda ash and coal influenced the choice of processes, contributed to greater expenditure of resources for a given output (as in the use of electric power in the direct electrolysis of shale), and limited yield of net product to less than optimum from given aluminous sources.

3. *The decline in alumina and aluminum production*

As indicated in Appendix Table 7, after the peak of May 1944, when alumina was being produced in Japan proper, Korea, and Formosa at an annual rate

of almost 360,000 tons, production fell precipitously and almost steadily to the end of the war. Since alumina stocks were little in excess of working inventories, decline in alumina production was paralleled by an equivalent decline in the production of primary ingot. From a peak rate of 180,000 tons per year in May 1944, the latter declined to a rate of 85,000 tons per year in December. By June 1945 aluminum production in these areas had fallen to an annual rate of 18,000 tons, supplemented by 8,000 tons in Manchukuo. Alumina, the limiting factor, was being produced in Japan and Korea in 13 plants—11 in Japan and two in Korea. Six of these plants—all in Japan—accounted for 82 per cent of this limited output. As noted above, the decline was primarily caused by the exhaustion of bauxite supplies, a situation which could not be compensated for by recovery from aluminous shale, local alunite, and clay within the Inner Zone.

4. *Effects of decline in primary ingot production*

a. *Changes in the distribution pattern.* As a result of the rapid decline in aluminum output, the existing supply was more completely mobilized for aircraft use. As indicated in Appendix Table 19, while during the first quarter of 1944 about 83 per cent of primary ingot was allotted to the "D" category, the percentage had risen to 89 per cent in the second quarter, and to virtually 100 per cent by the end of the year. The greater weight of early allotments, however, restricted the percentage allocation to aircraft of total allotments for the year to 89 (Table 4).

b. *Increased proportion of secondary utilization.* Quantities of primary ingot, despite closer control, were not alone sufficient for expected levels of aircraft output (ingot had to be supplied from 4.5 to 6 months before fly-away time). Resort had to be made, therefore, to increasing quantities of processing scrap. In the second quarter of fiscal 1944 virgin ingot constituted 75–78 per cent of aluminum entering the aircraft pipe line, a fairly normal relationship as compared with British and American experience. Thereafter the position deteriorated rapidly. During the third quarter the percentage of virgin varied between 30 and 50. By the fourth quarter virgin ingot was the source of only 20 per cent of available supply, scrap accounting for fully 80 per cent.

c. *Absence of quantitative shortage.* By utilizing such means to extend the available supply of primary aluminum, Japan was able successfully to supply the requirements for actual aircraft production. There is no information available that aluminum, in quantitative sense, at any point hindered aircraf production within the period of the war. But whil the quantity of aluminum was ample for more tha realized levels of plane production, the declinin quality of aluminum, in part due to high secondar utilization, must have had a significant effect o practicable levels and quality of aircraft output.

5. *The decline in quality of aluminum and i alloys*

a. *Declining purity of primary aluminum.* Th quality of primary ingot during the early years of th war was acceptably high. Data from the Bureau Mines, Ministry of Commerce and Industry, ind cate average purity during this period between 99. and 99.5 per cent, a standard of attainment confirme by analyses provided by individual companies. Bu when bauxite became critical and was replaced b other materials, there was a marked effect on tl quality of the product. Aluminum purity began t dip under 99.0 per cent late in 1944, and by the en of the war 98 per cent was the usual grade, with son output falling to 97 per cent or below (Append Table 21). The use of drosses and scrap in producir alumina aggravated the tendency, and some of tl "primary" metal made from drosses was poorer quality than scrap ingot.

The decrease in purity attending raw materia difficulties is reflected in the quality of ingot aluminu purchased for use in sand castings as reported b several foundries. The Katada plant of Sumitom Metals Industries, for example, reported receivi aluminum ingot of 99.3 per cent purity in Januar 1944. Thereafter it reported decreasing purity f periods as indicated in table 6.

TABLE 6.—*Decreasing purity of aluminum received by Kata foundry, Sumitomo Metals Industries*

Period	Minimum quality (per cent)
Before February 1944	9
February–April 1944	9
April–December 1944	9
December 1944–July 1945	97
August 1945	96

Source: Plant data submitted by Sumitomo Metals Industries to USSBS, Ba Materials division, November 1945.

Die casting plants experienced similar down gradin of raw material. Available data from die castin plants indicate normal purity of aluminum—99. per cent—shortly before the war, gradually decreas ing to 98.0 per cent by August 1943. Scrap was use largely thereafter.

The use of such lower grade aluminum necessarily affects adversely the efficiency of production, the quality of castings, and the strength and toughness of the product. Although castings of the strength and soundness required for aircraft are not satisfactory when produced from aluminum of this quality, the Katada plant was nevertheless casting airplane engine crankcases, cylinder heads, cylinder blocks, and other vital parts.

b. *Declining quality of aluminum alloys.* The decline in purity of primary aluminum, in addition to the quality deterioration due to increasing scrap ratios, resulted, moreover, in the break-down of close control of composition in specifications for aluminum alloys. While Japanese statements on harmful effects of contamination were vague, the evidence found in composition and analysis data is conclusive. Representative specifications of principal aluminum alloys for castings and wrought products were selected from "Japanese Aeronautical Specifications," issued by the Technical Institute (GIJUTSUIN), in November 1944, and are presented in Appendix Tables 22 and 23.

Examination of aluminum castings specifications particularly points up the breakdown of quality controls. Principal impurities are given liberal maxima, and little attempt is made to set an over-all impurity limit. Where such limits are established, they are so wide as to be practically meaningless. In specifications developed particularly for the use of scrap aluminum from aircraft plants or from wrecked planes, the range of alloying elements is much broader than in comparable American specifications, and amounts of several specific impurities are not controlled at all. It is probable that these "wartime aluminum" casting specifications were prepared simply to describe the scrap used, as the mechanical properties of castings made in accordance with them would be unpredictable. The range of permissible compositions is too wide to attempt to use such castings in any but unimportant applications; their heat treatment might or might not be effective, and production difficulties would certainly be expected.

Specifications for wrought aluminum alloys were not downgraded as far as those for castings. Although Japanese wrought alloys were similar to American in nominal composition, specifications provided less control of impurities, even in the period before deterioration in Japan's aluminum position. As the quality of primary ingot declined and the proportion of scrap increased, impurities increased, and specifications were broadened.

Progressive broadening of the ranges of the three principal alloying elements—copper, magnesium, and manganese—and the larger tolerance of the principal impurities—iron, silicon, and zinc—are striking. Furthermore, no limitation is made on other impurities, such as tin and lead, which might be very harmful if introduced with the scrap used. Such a relaxation of quality control could not have any effect other than the production of wrought products of inferior strength and inferior results in the heat treating process. Apparently an attempt was made to compensate for higher zinc and iron by a reduction in the magnesium content, but this would affect mechanical properties (yield strength, tensile strength, hardness, elongation). When questioned closely on this point, the Japanese admitted that mechanical properties were 10 per cent less on the average, but inspectors could reject for only so long, after which pressure for maintenance of production forced the acceptance of off-grade material.

It is not determinable from available data to what extent the materials made to these downgraded specifications were actually incorporated in finished planes, but it is probable that most of such aluminum by the end of the war was in the pipeline or diluted with purer grades. It is evident, therefore, that the Japanese aluminum supply position was more unfavorable than purely quantitative data suggest. Qualitative deterioration could have demoralized production in another six months' time.

6. *The Japanese aluminum position at the end of the war*

As a result of the operation of factors noted in preceding sections—chiefly exhaustion of bauxite supplies and cessation of aluminous shale shipments to Japan proper—by the end of the war the Japanese were left to rely for succeeding aluminum supply upon the following:

a. *Local alunite and alum-clay deposits.* The former, in Japan, are of very low grade, and while a small quantity of alumina had been produced from such resources, it is unlikely that such materials could have provided any significant quantities of aluminum. Development of large scale mining of alum-stone deposits by the Army had been started, but while research in methods of treatment had gone forward, no practical utilization of these ores had been made by the end of the war.

b. *The output of Korea and Manchukuo.* Korean aluminum production in June was at an annual rate slightly in excess of 4,000 tons per year, but was

falling rapidly because of transportation and raw material difficulties. Manchukuoan production was about 8,000 tons per year, but of declining quality. A large proportion of the latter was being used in Manchukuoan production in lieu of copper imports from Japan proper, the exported portion averaging roughly 50 per cent as late as the April-June quarter of 1945.

c. *Available stocks of ingot, secondary metal, fabricated shapes, and aluminum in work-in-process and working inventories in aircraft plants.* Stocks in ingot form were small, and the secondary aluminum available, while not precisely determinable, must have been declining significantly since processing wastage is a function of aircraft output. It is estimated that at the end of the war the principal stock of aluminum—about 50,000 tons—was in the form of semi-fabricated and fabricated shapes in the hands of fabricating and aircraft plants. Much of this was of high secondary origin, as noted above.

VII

EFFECTS OF STRATEGIC BOMBING

1. *Effects of direct attack*

a. No concerted attack on the aluminum industry was attempted. The total weight of bombs directed specifically against alumina and aluminum plants by the Fifth and Twentieth Air Forces was only 236 tons directed against four targets. Of this total, 197 tons or 83 per cent, was dropped in four raids against the integrated alumina-aluminum plant at Takao. Additional tonnage may have been directed against specific targets in the industry by naval carrier forces, but tonnages involved would have been small. In addition to the raids directed at the four specific targets (of which one did not hit the target area) some damage to the industry occurred as the result of spillovers from other raids, damage as a result of urban area raids, naval bombardment, and low level attacks by naval carrier forces against port areas or targets of opportunity.

b. A complete tabulation of plants attacked in the industry, with brief assessment of damage, is presented in Appendix Table 2. Selected data on the relative position of the six alumina and five aluminum reduction plants which suffered attack are presented in Table 7.

From the data of Table 7 it is evident that plants contributing about 50 per cent of alumina and 54 per cent of aluminum reduction capacity before attack were subjected to some damage. These plants, before attack, were contributing about 45 per cent of total production of alumina in Japan proper, Korea, and Formosa, and about 38 per cent of aluminum output. Except for the minor attack on the Takao plant in October 1944, no plant was operating, at the time of attack, at more than one-third of capacity. Except for the Formosa attacks and two small naval air raids on insignificant or inoperative plants in April,

TABLE 7.—*Alumina and aluminum plants damaged by direct attack*

Plant location	Dates hit [5]	Position before attack [1]		
		Relative importance		Ratio of production to capacity (per cent)
		Percentage of total capacity [2]	Percentage contribution to total production [2]	
Alumina plants				
Shimizu	10 June 7, 31 July, 2 August	29	24	1
Hachinoe	15 July	(3)	(3)	2
Niihama [4]	24 July	13	10	1
Iwate	10 August	(3)	1	2
Kawasaki	15 April	(3)	(3)	(3)
Takao [4]	12 October 44	8	8	6
	17, 18, 24 February; 1 March	8	10	2
Aluminum reduction plants				
Kambara	25, 30 July	23	16	
Niihama [4]	24 July	15	12	
Koriyama	12 April	2	(3)	(3)
	12 October 44	8	9	1
Takao [4]	17, 18, 24 February; 1 March	9	10	3
Karenko	12, 14 October 44	5	(3)	(3)

[1] Base period before attack taken in each case as calendar month preceding first dat hit, except for Takao plant, where position before second series of attacks is also given
[2] Total pertains to Japan proper, Korea, and Formosa.
[3] Less than 0.5 per cent.
[4] Integrated alumina-aluminum plants.
[5] All dates pertain to 1945, except where otherwise specified.

Source: Appendix Table 2.

all damage was suffered in June, July and Augus 1945, when the industry was operating at about 1 per cent of capacity and was rapidly running out o available supplies of aluminous materials. Becaus of the dominant restriction of production imposed by shortage of basic raw materials, it must be concluded that the chief effect of air attack, to the extent production was interrupted (Appendix Table 2), was t extend consumption of raw materials over a longer period.

c. The precedence in time, and relative weight of attacks on Formosa plants make them deserving of particular comment. Both the integrated alumina-aluminum plant at Takao and the aluminum reduc-

tion plant at Karenko were first attacked by rocket-firing naval planes on 12 October 1944, followed by a similar attack on Karenko two days later. With the first salvo the mercury arc rectifier of the Karenko plant was demolished, and the men of the general affairs section of the Japan Aluminum company have great regard for our aerial marksmanship. But the plant transformers had been destroyed by a typhoon in August, and since all electric power was bought from the Taiwan Electric Power company, the plant had been inoperative since that time. It was impossible to replace either the transformers or mercury arc rectifier. In the absence of bombing or transformer damage the plant would have been forced to close down shortly, for with declining alumina production at its sources of supply (the Kurosaki and Takao plants), it would shortly have had little on which to operate. Any aluminum which it would have produced after the period of attack would have been no net gain, for with alumina the restricted factor, such production would have been offset by less output elsewhere.

d. Effects of the October attack on the Takao plant were stated to be quite light. Bauxite stocks at the plant had disappeared early in 1944, and by the time of attack the main recovery of alumina had been from red mud (residual aluminum-bearing silicates of the Bayer process), supplemented by such quantities of bauxite as arrived sporadically. At the time of this first attack the plant had been reduced to operating at 60 per cent of its alumina capacity. By the time of the decisive Fifth AF bombings in February 1945, red mud was being utilized exclusively, and the plant was operating at 28 per cent of its alumina capacity. Bombing of the plant at this time halted all operations, but it is not likely the plant could have continued to produce any significant quantities of aluminum in any case. With reference to possible effects of the attack on plans for removal of the plant to the continent, company officials were certain it made little difference. The government had issued a directive in January 1945 to move the Takao plant, beginning in June, but no concrete plans had been considered either before or after the bombing. By March, the situation had so deteriorated that company officials were made aware that none of the necessary shipping would be forthcoming. In the comparable case of the company's Kurosaki plant, which was to be moved to Manchukuo, partial dismantling had begun, but, because of absence of shipping, the war ended before the transfer could be effected.

2. *Indirect effects of bombing, blockade, and transportation shortages*

The effects of the blockade and the shipping shortage on the decline of the aluminum industry are evident in much of the preceding analysis. The quantity of aluminum produced followed closely the rising and declining trend of bauxite imports. The attempt to shift to aluminous shale provided only small supplies of aluminum, and these quantities proved temporary as the blockade pinched off imports of aluminous shale. In the aluminum industry, at bottom, these factors were decisive. Additional factors affecting other raw materials through blockade and/or indirect air attack have been noted above.

VIII

SUMMARY AND CONCLUSIONS

Japan's bauxite position at the beginning of the war was precarious. Stock piles of 250,000 tons were sufficient for less than nine months at the existing rate of utilization, and for less than seven months at the realized rate of production during the period following December 1941. She was able to secure her position, however, by subjugating the southern area in time to step up bauxite imports during 1942 to 450,000 tons, a quantity in excess of that for any previous year.

During the first two and one-half years of the war, the Japanese were able sufficiently to expand alumina and aluminum reduction capacity in Japan proper, Korea and Formosa and to import sufficient bauxite to make possible expanded aluminum production and a fairly easy position in aluminum supply. Despite rising aircraft production, the doubling of primary ingot production (from 71,000 tons in 1941 to 141,000 tons in 1943) plus imports from Manchukuo provided a supply sufficient to permit allotment of more than one-third of such ingot in 1942, and as much as 28 per cent in 1943, to other than aircraft uses. With production during this period running close to operational capacity, the sizeable segment of

total supply allotted to other than aircraft uses indicates no great attempt to conserve aluminum either as bauxite stocks or in the form of ingot or other shapes for aircraft use in future periods, though the gravity of the shipping position was becoming apparent. Full restriction of aluminum to aircraft use was accomplished only late in 1944 when the new supply was already dwindling rapidly.

The most salient factor in the rapid decline in aluminum production in Japan proper, Korea and Formosa from an annual rate of 180,000 tons in May 1944 to a rate of 18,000 tons at the end of June 1945, was the sea-air blockade which severed connection with southern bauxite resources. Data on bauxite imports and stocks clearly suggest that until the end of 1943 the Japanese were able to import enough bauxite to maintain fairly consistent stocks, despite the expanding rate of utilization. By the end of June 1944, however, the situation was deteriorating rapidly. Although stocks of 176,000 tons still existed, they were falling precipitously, having been depleted by 120,000 tons in the preceding two quarters. After the invasion of the Philippines, bauxite imports were sporadic, and stocks of any appreciable magnitude disappeared after October.

The attempt at conversion of Bayer process alumina facilities to utilization of North China aluminous shale proved ineffective because (a) it was begun too late, (b) the Japanese ran into unexpected technical difficulties in operating under the new processes, and (c) by the time significant converted operational capacity had been established the sea and air forces had cut off the supply of aluminous shale. The total quantity of alumina produced during 1944 in Japan proper and Korea from non-bauxitic sources, including aluminous shale, alunite, alum-clay and scrap, was only 35,000 tons, the equivalent of about 17,000 tons of aluminum.

As a result of the decline in primary ingot production, the Japanese were forced to rely to an increasing degree on secondary, or scrap aluminum from processing wastage and other sources, until by 1945 fully 80 per cent of the aluminum entering the aircraft pipeline was derived from secondary sources. Scrap ratios of this magnitude together with declining purity of primary aluminum resulted in the breakdown of close composition control of aluminum alloys for cast and wrought products, in turn attended by severe production difficulties and deterioration in quality of product. Much of this aluminum by the end of the war was in the form of fabricated shapes and work-in-process, and probably the full effects of quality depreciation had not yet been felt by the aircraft industry.

Although quantities of new aluminum produced declined rapidly, the resort to secondary aluminum as noted above, was sufficient to maintain supply at a level adequate for the actual reduced rate of aircraft output resulting from direct attack on aircraft plants and efforts at dispersal within the industry. The declining new supply, thus, had not significantly affected aircraft output by the close of the war.

By the end of the war the Japanese could have counted on the continued supply of primary aluminum for aircraft from Japan proper and Korea plus receipts from Manchukuo at a rate not greatly in excess of 10,000 tons per year, providing that production in Korea and Manchukuo was not interrupted by bombing or occupation. It is likely, however, that the existence of supplies of aluminum in fabricated form plus secondary aluminum in the aircraft pipeline, and small quantities of virgin metal would have permitted maintenance of existing levels of aircraft output for several months, providing that quality deterioration would not have demoralized production.

The effect of strategic bombing on the aluminum industry, except as contributing to blockade and cutting off of necessary materials, was minor. No concerted attack on the industry was attempted, and such direct damage as was suffered by the industry except for the attacks on Formosa plants (which were inoperative or suffering seriously from lack of bauxite), occurred in June, July and August of 1965, when the industry was already operating at 12 per cent of capacity or less and was rapidly running out of usable aluminous materials.

MAGNESIUM

I

STRATEGIC IMPORTANCE OF MAGNESIUM

Magnesium is unique in two ways: it is the lightest in weight of common metals, and it burns intensely with a brilliant white light. The former property makes it a desirable metal for airborne devices of all kinds: landing wheels, instrument brackets and housings, camera mounts, automatic pilot parts and similar items. The latter property makes it valuable for flares, incendiaries, and other pyrotechnical devices. It is also an indispensable constituent of duralumin-type alloys used almost exclusively in the manufacture of aircraft. For some pyrotechnical devices and for dural there are no substitutes. For lightweight parts aluminum can be used with some increase in weight.

II

BACKGROUND AND PREWAR POSITION

1. *Development of capacity and production*

The metallic magnesium industry, like that of aluminum in Japan, is of very recent origin; hence its prewar history is characterized by rapid expansion, which carried on into the period of the war. The first Japanese plant, that of the Riken Metal Manufacturing company, was constructed in 1933 at Ube, Yamaguchi Prefecture. As indicated in Table 8, while capacity was almost tripled from 1935 to 1941—the number of plants increasing to eight—output increased by almost 600 per cent. Six of the eight plants were in Japan proper, with one each in Korea and Formosa (Appendix Table 25). As a result of such expansion, the Japanese supply situation had changed from early dependence upon imports for their small magnesium requirements to a slight and temporary surplus by 1940 which was disposed of by export. By the beginning of the war, therefore, Japan had developed a magnesium industry capable of producing more than was required for immediate consumption.

TABLE 8.—*Magnesium capacity and production in Japan proper, Korea, Manchukuo and Formosa, fiscal years 1935–45*

[In metric tons]

Year	Number of plants	Total capacity	Total production
1935	1	1,500	379
1936	1	1,500	637
1937	2	1,600	892
1938	3	1,950	1,156
1939	6	2,850	1,936
1940	6	3,650	2,806
1941	8	4,200	2,559
1942	9	4,832	2,678
1943	12	7,770	3,928
1944	14	10,440	5,125
1945, first quarter	13	10,660	901

Sources: Appendix Tables 25–27.

2. *Processes*

Of the several basic processes for magnesium production three were used by the Japanese, but two of them produced nearly all of the magnesium. The Ube plant of the Riken Metal Manufacturing company, first entrant into the field, utilized a process based on the raw material "bittern," or "bitter brine." A typical analysis of this material follows:

Constituent	*Per cent*
$MgCl_2$	17.6
$MgSO_4$	6.5
KCl	2.9
NaCl	3.6

In this process the brine was concentrated, and milk of lime added to precipitate $CaSO_4$, which was recovered as gypsum. The purified chlorides were then dehydrated in coal-fired pans, cooled, KCl and NaCl added, and the mixture crushed. Complete dehydration was obtained in electric furnaces with evolution of chlorine and hydrochloric acid, the power consumption being given as 2,200 KWH per ton of magnesium at 100 volts and 5,000 amperes. The dehydrated chloride mixture was then electrolyzed, the power consumption being 18,000 to 26,000 KWH per ton of magnesium. Chlorine gas and hydrochloric acid were recovered by absorption in milk of lime. The metallic magnesium was cast into pigs under a sulphur dioxide atmosphere. Difficulties were experienced with the life of the dehydration pans, the dehydrating furnaces and high power consumption.

A second process, similar to that developed in Germany by the I.G. Farbenindustrie, was first used in the plant erected by the Asahi Electrical Industries

company at Ogu, Tokyo, in 1937. Magnesia and charcoal were crushed, mixed and fused in an electric furnace. Chlorine gas was blown through, and the anhydrous magnesium chloride thus formed was electrolyzed, forming metallic magnesium and chlorine.

A third process—the carbothermic, or Hansgirg—was first used in 1938 by the Nichitsu Magnesium company at Konan, Korea. This method involves the high temperature reduction of magnesite with carbon, and rapid condensation of magnesium powder in a stream of reducing gas. The magnesium powder is subsequently recrystallized and then melted and poured into ingot. Many difficulties were experienced in the use of this process at the Permanente magnesium plant in California. The Nichitsu plant seemed to be reasonably successful, but was the only plant to use this process.

A breakdown indicating the number of plants utilizing each process together with the percentage of total output produced by each is provided in Table 9.

TABLE 9.—*Magnesium production by process, fiscal year 1941*

Process	Number of plants	Percentage of total output
Asahi	4	49
Brine	3	42
Hansgirg	1	9
Total	8	100

Source: Appendix Table 26.

Among alternatives available, the ferro-silicon or Pidgeon, process was not used by the Japanese; nor was sea water used as a source material in the brine process, though it was considered as "bitter brine" became limited in supply during the course of the war.

III

MAGNESIUM SUPPLY DURING THE WAR

1. *Wartime controls*

In the development of wartime controls by governmental and quasi-governmental bodies, magnesium and aluminum, of especial interest because of their close relation to aircraft production, were administered by organizations devoted specifically to the light metals. A short account of such organizations and related functions has been included in the preceding aluminum section of this report.

2. *Capacity and production*

The expansion of Japanese magnesium capacity, proceeding at a rapid rate at the beginning of the war, was continued well into 1945. By 1944 capacity had reached a level in excess of 10,000 tons,[1] about 2.5 times the 1941 figure of 4,200 tons (Table 8). This degree of expansion was accomplished by augmenting the facilities of existing plants in Japan proper and Formosa and constructing six new plants on the continent—five in Korea and one in Manchukuo (Appendix Table 25). The knocking out of the Formosa plant in February reduced the total number of plants in 1945 to 13, but the development of capacity in existing plants provided a slight increase in total capacity by June of that year. As indicated in the following breakdown, at the end of the war capacity in Japan proper was about equal to that in Korea, but was exceeded by total continental capacity.

[1] Metric tons are used throughout this report, years, unless otherwise specified, are fiscal.

Area	*Per cent*
Japan proper	45
Korea	46
Manchukuo	9
Total	100

Production, like capacity, increased rapidly until May 1944 when magnesium was being produced at an annual rate of 6,000 tons. Although production rates thereafter declined somewhat, total output of 1944 nevertheless exceeded 5,000 tons, about double that of 1941. Thereafter, while continental production was largely maintained, by the first quarter of 1945 production in Formosa had disappeared, that in Japan proper had been reduced by almost 50 per cent, and the annual rate had dropped to less than 4,000 tons (Appendix Tables 27–28). Output at this time was being produced by processes as indicated in Table 10. Of the total output in 1945, 50 per cent was being produced in Korea, 41 per cent in Japan proper, and 9 per cent in Manchukuo.

TABLE 10.—*Magnesium production by process, first quarter, fiscal 1945*

Process	Number of plants	Percentage of total output
Asahi	6	30
Brine	6	59
Hansgirg	1	11
Total	13	100

Source: Appendix Table 26.

3. *Raw material supplies*

Definitive reasons for the decline in magnesium production in Japan proper cannot be given with complete assurance, but available evidence tends to place greatest stress on shortages of raw materials. The principal magnesium-bearing materials—magnesite, magnesia, and bitter brine—had to be imported almost exclusively from the continent. Ordinary salt, also largely imported, was important as a source of chlorine and as a constituent of the fused chloride used in the final electrolysis. The statistics on imports and stocks of magnesite and magnesia are not conclusive because both were used in larger quantities as refractory materials. Data on imports and stocks of brine are fragmentary. However, officials of the Bureau of Mines, Ministry of Commerce and Industry and the Light Metals Control association (KEIKINZOKU TOSEI KAI) were definite in the opinion that shortages of these materials—magnesite, magnesia, brine and salt—were the most important factors contributing to the decline in magnesium production. Limited data available from individual producers particularly stress the shortage of salt.

4. *Limited use of sea water*

Because of the difficulties experienced in securing brine and salt, experimentation was begun in the use of sea water as a source of both magnesium and chlorine. In 1941, using sea water, the Riken Metal Manufacturing company at Ube began work on what was called the magnesium hydrate method. Production from this process was first reported in July 1942. By the end of 1944, production from sea water comprised 30 per cent of Riken's monthly magnesium output of 40 tons. During the first quarter of 1945 Riken produced 83 tons of which 24 tons (29 per cent) were produced from sea water. Owing to the character of the evidence, the performance at the Riken plant is far from conclusive that the industry would have been better off had it adopted the sea water process in the first instance, although that would be the normal expectancy in view of the raw material troubles encountered.

5. *Stocks*

Data on stocks of magnesium ingot are meager. The Light Metals Control association reported magnesium stocks on hand as of 31 August 1945 as only 41 tons. Since allocation data indicate the distribution of quantities closely approximating those produced, it is probable that only working stocks were maintained and that the metal was used as fast as it was produced.

IV

DISTRIBUTION OF MAGNESIUM

The distribution of magnesium was fairly simple, about 90 per cent of all magnesium available during the period of the war being directed into aircraft channels (Appendix Table 29). Some slight increase in trend is noticeable, the percentage so allocated increasing from 87.2 in 1943 to 90.3 in 1944, and finally to 94.9 in the first quarter of 1945. Quantities allocated to aircraft provided not only for direct uses in planes, but also for airborne equipment and for alloying with aluminum. Alloying requirements probably amounted to almost 1,500 tons per year during the war, as both duralumin and the zinc-bearing aluminum alloys used by the Japanese contained about 1.5 per cent magnesium. Only small quantities were used for pyrotechnics, and practically the only indirect military and civilian uses allowed during the war were the comparatively small quantities required for photographic flash bulbs, vacuum tube "getters," organic synthesis, and the like. There was always enough magnesium for alloying and pyrotechnics, the minimum essential uses. If more magnesium had been available, it could have been substituted for aluminum in many components of aircraft manufacture, but such substitutions, as noted below, would have been limited by qualitative factors.

V

QUALITY OF JAPANESE MAGNESIUM

Analyses of magnesium output from two of the leading Japanese producers show a lower standard of purity than minimum American standards of 99.8 per cent. Particular difficulty in maintaining stand-

ards was encountered during 1944 and 1945 as raw materials became increasingly short (Appendix Table 30).

Specifications for Japanese magnesium alloys show the same lack of appreciation for quality apparent in the analyses of the pure magnesium. Typical examples taken from "Japanese Aeronautical Specifications," November 1944, provide only nominal composition ranges. Similar specifications published by the Furukawa Electric company supply impurity limits usually of 1.0 per cent, but sometimes 0.5 or 1.5 per cent (Appendix Table 31). No mention is made of specific impurities—copper, nickel, and iron—which are harmful to corrosion resistance and are usually limited by American specifications to .03 or .05 per cent each, and in special grades of wrought products and castings to as low as .002 per cent. Such quality would be virtually impossible with the usual grade of Japanese magnesium ingot.

With the use of magnesium so definitely limited by the supply, the quality was probably good enough, especially as an alloying agent in aluminum alloys and for pyrotechnics. For aircraft landing wheels and other castings in engines and instruments it was also adequate. If, however, supplies had been sufficient to extend its use as a substitute for aluminum, higher quality would have been necessary. It is apparent, therefore, both from quantitative and qualitative considerations, that Japan was not ready for full exploitation of the use of magnesium.

VI

EFFECTS OF STRATEGIC BOMBING

No concerted attack was directed against the Japanese magnesium industry. Information available indicates that probably all damage in the industry was the result of urban area or naval carrier attacks, or incidental to attacks on other plants. Details of attacks and resulting damage are presented in Appendix Table 2. Of the four plants subjected to damage in Japan proper, representing 38 per cent of total capacity and contributing 23 per cent to total production before attack, only one had been damaged by April 1945. All other damage in Japan proper occurred in late June, July, and August when production was already declining. No plant was operating at more than 30 per cent of capacity, and only one plant—contributing only 2 per cent of total production—was put out of production for an extended period before the end of the war, the stoppage being due to labor shortage resulting from destruction of housing. None of the plants in Japan proper suffered damage to critically necessary equipment. The single Formosa plant at Takao ceased production in February 1945. While no specific additional data on the plant are available, the stoppage was probably caused by the series of Fifth AF attacks on the Takao aluminum plant during February and early March (Appendix Table 2). Before attack, however, the plant was operating at but 30 per cent of capacity and producing only 4 per cent of the total Japanese production.

It may be concluded that the magnesium industry properly was not selected for heavier or more sustained attack. At the end of 1944 about half of Japanese magnesium capacity was situated on the continent with more favorable access to raw materials. During the March-April quarter of 1945 the continent was producing 60 per cent of total Japanese output of 4,000 tons per year. Even total destruction of capacity in Japan proper and Formosa would have left ample production for meeting essential requirements for alloying, pyrotechnics and minor special uses, particularly since reduced primary aluminum production had by June cut alloying requirements to less than 500 tons per year. The surplus over minimum requirements could have been used to substitute for aluminum, but such excess would have been negligible in relation to total aluminum requirements, and could not have justified attack from the standpoint of affecting aluminum supply.

COPPER

I

THE STRATEGIC IMPORTANCE OF COPPER

The strategic importance of copper lies in its principal uses—as an electrical conductor, as the basic constituent, together with other non-ferrous metals, in brass and bronze castings and in cartridge brass. With the exception of silver, which is inadequate in supply, no other metal approaches the conductivity of copper. Aluminum, the only other substitute, has 58 per cent of the conductivity of copper, but because of its great importance and extensive use in aircraft it is generally not available in sufficient quantity to be freely used as a substitute for copper in a war economy. The physical and chemical properties of copper make it important as the primary metal used in brass and bronze castings. Substitutes for its use in bearings and in other castings where non-corrosive properties are required are not yet abundant. Cartridge brass absorbs enormous amounts of copper in wartime, and the substitution of steel has generally proven unsatisfactory because of the technical difficulties involved and the physical properties of steel which normally produce an inferior and less reliable cartridge case.

II

COPPER SUPPLY POSITION IN JAPAN BEFORE PEARL HARBOR

1. *Copper production in Japan proper*

a. *Mine production.* Copper ore in Japan is mined principally by seven companies which own the 15 largest mines, accounting for 70 per cent of total production. Mines are located on each of the four main islands. With the exception of two mines brought into production in 1942 and 1944, all others had been developed prior to 1935 and many were producing during World War I.[1] Data prior to 1940, while incomplete, are sufficient to indicate that mine production from 1935 to 1941 had been fairly constant, although some shifts in the relative importance of individual mines had occurred. Mine production during that period ran between 73,000 and 77,000 tons of copper content annually.

b. *Smelter capacity and production.* Thirteen smelters owned by nine companies were engaged in smelting copper ore and ore concentrates. All but three were producing blister copper prior to 1935; one (at Miyako) started production in 1937 and the remaining two (at Yokkaiichi and Kumitomo) in 1940.

(1) *Capacity.* Complete data on smelter capacity could not be obtained in Japan owing to the absence of any uniform basis for rating capacity. It was ascertainable, however, that in addition to the increase in capacity resulting from the establishment of the three new plants mentioned above, two older plants, Hitachi and Naoshima, were enlarged in 1938 and 1939 respectively. Estimates of total industry capacity can be made only within broad ranges, but it is reasonably certain that by 1940 smelters located in Japan proper had developed plant capacity to produce 130,000–150,000 tons of blister copper annually depending upon the quality of raw materials used. This estimate is substantiated by statements of industry officials and Bureau of Mines experts to the effect that capacity for some years had been in excess of that needed to handle both locally mined and imported ores.

(2) *Production.* Data on blister copper production are incomplete prior to 1940. Production from domestic and imported ores in 1940 and 1941, however, was approximately 92,000 tons annually.

c. *Refinery capacity and production.* Electrolytic copper is produced principally by eight companies owning nine refineries. These account for over 95 per cent of total production.

(1) *Capacity.* Again capacity figures are incomplete, but they show the entry of two new plants since

[1] Years, unless otherwise indicated, are fiscal. Metric tons are used throughout.

1935, namely, at Miyako in 1937 and at Yokkaiichi in 1940. In addition, two plants expanded their capacities—Osaka in the period 1939–40, and Nikko in the period 1940–41. Capacity appears to have been in excess of that needed during 1935–41; this assertion is also substantiated by statements of industry and government officials. Incomplete data (Appendix Table 33) show what may be regarded as a minimum capacity in 1941 of 135,000 tons electrolytic copper annually. In all probability the single important plant for which data are not available had a capacity in that year as large as its reported 1943 capacity. Total capacity for 1941 can then be estimated as approximately 147,000 tons annually.

(2) *Production.* Data for years prior to 1940 are not fully available, but in 1940 and 1941 approximately 108,000 and 103,000 tons of electrolytic copper were produced.

d. *Scrap production.* Figures are available for collection of old scrap, 1940–41. These include only that portion of copper and copper alloy scrap suitable for direct use by foundries and rolling mills and amounted to approximately 27,000 tons of copper content annually. Roughly equivalent to 25 per cent of annual production of refined copper in the same period, old scrap was an important source of copper to Japan.

2. *Copper production in Japanese-controlled areas outside Japan proper*

Data on copper produced in these areas are of a very sketchy nature but such as are available and may be of interest have been recorded here.

a. *Formosa.* Copper was produced in Formosa before the war on a small scale, but no records of the amounts existed in Japan.

b. *Korea.* Data on this area are nearly as inadequate as that for Formosa. However, the Japan Mining company has submitted blister copper production figures (Appendix Table 38) for its Chinnampo smelter. By 1940 output had reached an annual peak of about 8,000 tons of blister copper. No information was available on production of other Korean installations for this period, though it is highly probable that the Chinnampo smelter was not the only one in operation. All output of the Chinnampo smelter was shipped immediately to the Saganoseki refinery in Kyushu.

c. *Manchukuo.* In 1937 a five-year plan for exploiting Manchukuoan natural resources was drawn up by the Japanese government. A copper industry was among those initiated at that time. In 1941, the final year of the plan, 538 tons of electrolytic copper were produced, according to a report presented to the 86th Diet session.

3. *Imports of copper to Japan proper*

a. *Ore and ore concentrate.* Import data for 1935–40 are not available, but in 1941, copper ore and ore concentrate imports amounted to a minimum of 11,670 tons of copper content. Most important suppliers were South America, Canada, the Philippines and Formosa.

b. *Blister copper.* The only reported imports of blister are those of the Japan Mining company from its Chinnampo smelter in Korea. These reached a peak in 1940 when nearly 8,000 metric tons were sent to the Saganoseki refinery in Kyushu. There is some indication that other blister copper produced in Korea may also have been imported, but no statistics are available.

c. *Electrolytic copper.* Japan's imports of electrolytic copper were largely from the United States in the period 1935–41. Chile, from 1939 to 1941, was an increasingly important source. The dependence of Japan upon imports is illustrated in Table 11.

TABLE 11.—*Production and imports of refined copper, Japan proper, fiscal years 1937–41*

[In metric tons]

Year	Production [1]	Imports [2]	Production plus imports
1937	63,836	72,278	136,114
1938	69,999	102,306	172,305
1939	70,142	120,251	190,393
1940	108,216	119,392	227,608
1941	103,387	38,486	141,873

[1] Production data for three major plants were not available for 1937–39. None of the production figures include production from scrap refined on toll for the Army and Navy.
[2] Imports exclude imports from China and 1938 imports from Manchukuo and Chile which may have been received, but which would have been insignificant in amount.

Source: Appendix Table 32.

Production for the period 1937–39 may be assumed to have been less than that recorded for 1940–41. Unknown quantities of scrap refined on toll and excluded from these figures would not be sufficiently significant to affect the conclusion that imports played an increasingly important role in Japan's total refined copper supply position and that by 1939–40 their contribution was larger than that of domestic production. In 1941, owing to embargoes against shipments to Japan, imports fell off but still accounted for approximately 30 per cent of total supplies.

4. *Exports*

Japanese exports of copper have never been large. Figures obtained from the Bureau of Taxation, Ministry of Finance, (Appendix Table 44) indicate, however, that annual exports of shapes and manufactured products totalled about 18,000 tons in 1935 and declined gradually to less than 5,000 tons in 1941. Exports were primarily of shapes, as manufactured products never amounted to more than 350 tons in any one year. Among total exports, wire accounted for roughly 65 per cent until 1941 when its contribution declined to 50 per cent. Wire cable and sheet were next in importance. Exports were largely to Manchukuo, China, India and the Netherlands East Indies.

5. *Consumption*

Because almost all records had been destroyed by air attacks, information on consumption could not be furnished by the pertinent non-ferrous metals organizations. Furthermore, the inadequacy of available data relating to domestic production, imports and stockpiles makes it impossible to arrive at accurate estimates of pre-war consumption. Consequently, it can only be said that, since minimum stockpiles are ascertainable, consumption of copper in Japan prior to the outbreak of the war was something less than available annual supplies.

6. Summary of the Japanese copper supply position at the outbreak of the war.

Two noteworthy factors affected Japan's copper position at the outbreak of the war. First, dependence upon imports of refined metal was high and primary sources were outside of her control. But, secondly, domestic production was founded principally on domestic ores and was therefore relatively invulnerable. Home production would, in all likelihood, be inadequate to meet the expanded requirements of wartime, but large imports in the last few years had permitted the accumulation of sizable stockpiles. Stocks of electrolytic ingot held by the Metals Distribution company, the Army and the Navy are estimated to have been about 105,000 tons at the end of March 1942. Those on hand four months earlier when the war began were no doubt approximately the same. Confronted with this situation, Japan could follow three courses of action, and the vigorous prosecution of all of them would be necessary to a successful war effort. First, she could develop further her Formosa and China sources of ore and ore concentrates and her newly established Manchukuo copper industry. Secondly, she could capture and exploit enemy resources, such as the Philippines. Thirdly, she could develop further her own mine resources.

III

COPPER SUPPLY DURING THE WAR

1. *Imports*

In the several years immediately preceding Pearl Harbor, Japan's dependence upon imports of refined copper had progressively increased, as previously noted. The embargoes applied in 1941 almost completely cut off this source of supply. Thereafter copper imports were of negligible proportions as shown in Table 12.

TABLE 12.—*Imports of copper into Japan proper, fiscal years 1942–44*

[In metric tons]

Year	Ore and ore concentrates[1]	Blister copper[2]	Electrolytic copper[3]	Total
1942	11,378	4,511	690	16,579
1943	11,508	4,619	2	16,129
1944	5,503	5,106	3,910	14,519

[1] Copper content.
[2] Weight of blister (96 per cent copper). All from Korea.
[3] Although totals are incomplete, the quantity of electrolytic copper which may be excluded is believed to be small.

Source: Appendix Table 32.

It is apparent that in contrast with prewar imports wartime imports were relatively insignificant; the contribution which they made to the average annual reported supply of refined copper in the war years 1942–44 did not exceed 15 per cent. One promising source of ore and ore concentrate was particularly disappointing to Japan. Exploitation of captured Philippines mines produced in the peak year of 1943 less than 7,000 tons of copper imports. In addition, imports of blister from Korea never again reached the prewar peak. Imports failing, necessity forced reliance on domestic production.

2. *Production in Japan proper*

a. *Mine production.* Spurred by falling imports and increasing copper requirements, the Japanese made every effort to increase domestic mine output. These efforts were partially successful, as shown in Table 13. Output increased steadily and reached a peak in 1943 of 24 per cent above that of 1941.

TABLE 13.—*Copper mine production, Japan proper, fiscal years 1941–44*

[In metric tons of copper content]

Year	Production	Index
1941	72,504	100.0
1942	81,068	106.0
1943	94,475	124.0
1944	81,433	106.0
1945: First quarter	[1] 12,000	63.0

[1] Estimated.

Source: Appendix Table 34.

Available monthly data for eleven mines accounting for approximately one-half of total mine production are set forth in Table 14, and provide a picture of the trend of mine production in 1942–45. Production increased steadily, reaching its maximum during the seasonal peak in September 1943 and continuing at a substantially higher level than in the preceding 12 months. A second peak occurred in the succeeding September. Thereafter, partly owing to seasonal factors, output dropped abruptly. The declining level of production for the last six months of the fiscal year 1944 is reflected in the annual total which dropped to the level of 1942 output.

TABLE 14.—*Output of 11 selected mines, Japan proper, monthly, fiscal years 1942–45*

[In metric tons of copper content]

Month	1942	1943	1944	1945
April	3,004	3,478	4,032	2,122
May	3,038	3,573	4,330	2,260
June	2,938	3,566	3,992	1,831
July	3,624	3,381	3,542	...
August	4,135	4,760	5,271	...
September	3,427	5,588	5,416	...
October	3,177	3,871	2,850	...
November	3,090	3,827	2,491	...
December	3,253	4,265	2,750	...
January	3,271	4,109	2,348	...
February	3,592	4,353	1,901	...
March	3,746	4,519	2,596	...
Total	40,295	49,290	41,519	6,213

Source: Appendix Table 35.

Mine production in the later months was affected by shortages of skilled labor, explosives, rubber foot gear, work clothing, and mining tools. In addition, a lack of proper food caused a decrease in the efficiency of common labor. A shortage of repair materials, together with the all-out effort to achieve maximum short-run production, led to a neglect of maintenance policies and to a general deterioration of mines and equipment. In some cases a deterioration of ore values also occurred.

b. *Smelter production.* Keeping pace with mine output, blister copper production increased steadily, reaching an annual peak in 1943 of about 110,600 tons. Monthly data appear in Table 15. The highest month, September 1943, coincided with the peak of mine output.

TABLE 15.—*Total blister copper production, Japan proper, monthly, fiscal years 1942–45*

[In metric tons]

Month	1942	1943	1944	1945
April	7,009	8,509	8,873	[1] 3,829
May	7,832	7,919	8,200	[1] 3,859
June	7,122	8,962	8,378	[1] 2,426
July	6,720	8,442	6,709	...
August	7,164	9,654	8,052	...
September	6,944	10,052	8,726	...
October	8,853	8,582	6,770	...
November	9,503	9,652	6,399	...
December	9,365	9,875	6,847	...
January	8,402	9,417	6,335	...
February	8,593	9,905	5,456	...
March	9,795	9,639	6,427	...
Total	97,302	110,608	87,172	...

[1] Data from 3 out of 13 plants not available.

Source: Appendix Table 37.

Smelting was maintained at a relatively high level until June 1944 when output dropped below the corresponding month in the preceding year. Following a severe seasonal slump in October, smelter production—like mine production—never recovered. Available ore supplies, of course, set a theoretical limit on the production of blister copper, and in 1944 these declined 18 per cent from 1943, almost the same rate at which blister production declined. However, ore shortages appear initially not to have been the limiting factor.

Stocks of ore and ore concentrates at smelters are reported by the Mining Control association (Kozan Tosei Kai) to have increased progressively from 8,000 tons of copper content at the end of June 1943 to 18,000 tons at the end of September 1944. After that, blister production substantially declined as stocks were drawn down to less than 1,500 tons in the three months following. Failure to utilize these stocks suggests that factors other than ore shortages were the immediate cause of decreasing output. Industry officials explained the decline as the result of shortages of coal and concentrating acids, and the decline in labor efficiency. Coal in particular presented a serious problem; it had already deteriorated in quality, and by the summer of 1944 even the poorer grades became short in supply. Plant capacity was never a limiting factor in the smelting of copper ore.

c. *Refinery production.* Table 16 presents monthly statistics on electrolytic copper production in Japan proper for 1942–45. It will be noted that the general trend previously observed in mine and smelter out-

put was not as marked in the case of the refineries. However, in 1943 production steadily increased, and by August was well over 10,000 tons per month. This level was maintained until July of the following year, with the peak month of 11,700 tons in March 1944. From July 1944 on the trend declined rapidly, chiefly because of the decline in available scrap and blister, but accentuated by shortage of electric power and transportation difficulties which delayed delivery of blister anodes and acids necessary to the refinery process. Subsidiary difficulties were the inability to maintain plants properly and the loss of skilled labor. Refining capacity—like smelting capacity—was not a limiting factor on output, as the figures available indicate it to have been sufficient to handle more than 150,000 tons of electrolytic copper annually at the end of the last quarter of 1944.

TABLE 16.—*Electrolytic copper production in Japan proper, monthly, fiscal years 1942–44* [1]

[In metric tons]

Month	1942	1943	1944
April	8,681	9,015	10,833
May	8,494	9,521	10,637
June	8,386	9,380	10,449
July	8,821	9,614	8,182
August	8,758	10,427	8,854
September	8,777	10,987	9,080
October	9,055	10,199	8,358
November	8,961	10,136	7,580
December	9,960	10,469	7,326
January	8,203	10,471	5,751
February	8,263	10,693	5,964
March	8,698	11,748	6,191
Total	105,057	122,860	99,205

[1] Data exclude an indeterminable production from scrap refined on toll for the Army and Navy.

Source: Appendix Table 41.

Comparison of electrolytic production figures with total deliveries of copper by the Metals Distribution Control company (KINZOKU HAIKYU TOSEI KAISHA), which handled all deliveries of copper for the industry, indicates that the production shown in Table 16 does not include all production. At least 25,000 tons of additional copper were produced, but unaccounted for, in 1943 and 1944. Deliveries by the control company amounted to 254,011 tons during those years, but withdrawals from stocks of 3,032 tons and production of 225,977 totalled only 229,009 tons. Officials attributed the difference to unreported metal refined on toll for the services by the member concerns and to the repayment during the period of metal which had been earlier "loaned" to the Army and Navy. Detailed figures permitting the distribution of the 25,000 tons over the period could not be obtained.

d. *Scrap production.* In 1942, collections of old scrap suitable for direct use by foundries and rolling mills amounted to 14,700 tons (copper content), about one-half of collections in the preceding years. In the next two years, collections declined still further. In addition to domestic scrap collections, fairly large collections of old scrap from China were reported to have been made by the Army. No figures were available on new scrap production.

3. *Production in controlled areas outside of Japan proper*

a. *Formosa and Korea.* Reference already has been made to copper obtained from Formosan and Korean sources. No further information is available on Formosa. However, in addition to the known imports of blister from Korea, an additional 2,600 and 1,800 tons for 1943 and 1944, respectively, are reported to have been produced and these, of course, were available for Japanese use.

b. *Manchukuo.* While unimportant in terms of total output, the outcome of Japan's efforts to develop a Manchukuo copper industry are of interest. Following the first five-year plan, a second plan was promulgated in which primary interest was to be put on coal and agricultural products with secondary consideration given to production of non-ferrous metals. However, plans were made for the development of copper mines and construction of additional concentrating facilities, quotas were set, and considerable effort was expended in exploiting this source of supply. Planned capacity on completion of the project for refined copper was 7,920 tons a year, and expected production was 5,200 tons annually. In spite of these efforts, output of electrolytic copper in 1942 reached only 2,611 tons and thereafter declined to 1,736 tons in 1943 and to 966 tons in the first eight months of 1944. Small exports of copper are reported from Manchukuo in 1942, but statements of industry and government officials indicated that local production was insufficient to take care of domestic requirements and that imports from Japan were necessary.

4. *Copper supplies at the end of the war*

Output of electrolytic copper declined in 1944 to a point below prewar levels and partial data for 1945 make it reasonably certain that the decline continued to the end. Despite efforts to substitute other materials for copper in certain uses, supplies became less and less adequate, and stocks in the hands of the control company, Army, and Navy declined 70 per cent by the end of the war. Exports of copper which,

even in the prewar period, had been relatively small almost disappeared and over the entire war period were reported to total less than 5,000 tons, most of which was for Japanese use overseas.

IV

WARTIME USE OF COPPER

1. *Wartime controls*

Prior to 1938 copper and other non-ferrous metal industries were not under direct government control, although the industries themselves had set up "cooperative" societies. Under the impetus of the Chinese Incident, in November 1938, government-sponsored control societies were organized for each metal and a government decree was issued ordering all refinery output and all imported metal to be sold through the appropriate association.

In October 1940, the desire to provide a single coordinating body to deal with all phases of the non-ferrous metal and mineral industries was satisfied in part by the establishment of the Japan Metal and Mineral association (Nippon Kinzoku Kogyo Rengo Kai). This organization was privately supported by all the leading companies, but was not endowed with powers of governmental control. Its purpose was to deal with such problems as production, distribution, labor, and techniques common to the industries. Following the outbreak of war, it was superseded on 18 December 1941 by the present Mining Control association (Kozan Tosei Kai) which apparently absorbed both the ideas and the personnel of the private association. Endowed with authoritative powers, it was established to act as an intermediary between the government and private enterprise.

In February of 1942 the control societies set up in 1938 were combined to form the Japan Metals Distribution company (Nippon Kinzoku Haikyu Kaisha), which operated as the distributing subsidiary of the Mining Control association. Two years later, in a move to minimize the power of the shareholders (the principal non-ferrous metal producers), it was reorganized as an agency to carry out the directives of the Munitions Ministry and was renamed the Metals Distribution Control company (Kinzoku Haikyu Tosei Kaisha).

In addition to those agencies dealing principally with primary metal production and distribution, several companies were organized in 1938 to control each secondary metal and in July 1942 these were consolidated with similar organizations in iron and steel. The new organization was called the Metals Collection Control company (Kinzoku Kaishu Tosei Kaisha) and included as its members dealers in scrap metals. Its function was to encourage scrap collection and to provide a single channel through which scrap metal could be distributed to users.

It is thus apparent that wartime controls over non-ferrous metals were centered ultimately in three organizations, the Mining Control association, the Metals Distribution Control association and the Metals Collection Control association, all of which carried out the directives of the Ministry of Munitions. The Mining Control association collected estimated production statistics for mines, smelters and refineries for the purpose of planning transportation needs and for furnishing to the Munitions Ministry data for the supply side. The Munitions Ministry on the basis of that knowledge made over-all allocations for the next fiscal year to the Army, Navy, indirect military and civilian and other general categories. Allocations were revised quarterly on the basis of a more exact knowledge of the total supply.

The Army and the Navy each made totally arbitrary demands and refused to furnish the government with any details of the use to which allocations were put. The indirect military and civilian demands were made up through combining the requests of each control association, which in turn had coordinated the needs of all its company and plant members. The actual distribution within the Army and Navy was made as each branch saw fit. The suballocation of the amount going to the indirect military and civilian category, the only freely circulated suballocations, was made by the Munitions Ministry.

The Metals Distribution Control company was assigned the function of handling the receipt and distribution of all the nonferrous refined metals. Every ton of imported or domestically produced metal was sold to this company and stored in its warehouses. Delivery from the warehouses was made only upon the presentation by the claimant of an authorization-of-purchase chit issued by the Mining Control association. The control company also served as an instrument for the payment of government subsidies to refineries. While early in the war the company paid each refinery on the basis of its

particular cost of production, and then sold the metal to consumers at a price based on average cost, it later became necessary—because of rising costs—to establish a fixed price to consumers, and the government made up the difference in purchase and sale price to the company.

Secondary metal, unrefined, was distributed and sold by the Metal Collection Control company directly to foundries or rolling mills. The small portion of scrap which was refined for this company was done on a toll basis, but passed at once by purchase into the hands of Metals Distribution Control association.

Refined copper was handled in the manner described above. However, as previously noted, one serious leak existed in the control system. Scrap collected by the Army and Navy was frequently sent to refineries in substantial quantities where it was refined on a toll basis and returned to the services directly. These quantities, despite orders to the contrary, were excluded from refinery production figures submitted to the Mining Control association. Neither did this refined copper enter Metals Distribution Control company's records except when occasioned by repayment in kind of a former "loan" to the services.

2. *Distribution*

The principal claimants for copper supplies and the proportion of total allocations to each are shown in Table 17. The extent to which Japan planned to channel her refined copper to meet military requirements is clear.

TABLE 17.—*Planned allocations of refined copper, fiscal years 1942–44*

[In metric tons]

Claimants	1942		1943		1944	
	Quantity	Percent	Quantity	Percent	Quantity	Percent
Army	25,828	29	34,505	29	14,819	16
Navy	45,040	51	54,793	46	17,653	19
Indirect Military and Civilian	18,036	20	30,726	25	15,928	17
Aircraft	(1)	(1)	(1)	(1)	28,354	30
Shipping	(1)	(1)	(1)	(1)	16,922	18
Total	88,904	100	120,024	100	93,676	100

[1] Aircraft included in Army and Navy allocations; shipping included in Navy prior to 1944.

Source: Appendix Tables 46 and 48.

The Navy, including allocations to shipping and approximately one-half of allocations to aircraft in 1944, was to receive about 50 per cent of the total. Allocations to the Army, including one-half of aircraft allocations in 1944, amounted to about 30 per cent of the total.

Allocations to indirect military and civilian categories are shown in greater detail in Appendix Table 48. The largest item within that category was exports, which amounted to roughly 30 per cent of the total. As the allocations substantially exceeded exports as reported by the Bureau of Taxation, it is possible that they may have carried lower priorities and that sufficient metal was never available for this purpose. Amounts allocated to industrial categories increased between 1942 and 1943 in response to industrial expansion requirements in that period. Only one category, "general civilian demands," appears to include allocations for purely civilian uses, and the small amounts designated for this purpose were only 3 per cent of total allocations.

More indicative of amounts actually received by the major claimants are the contractual delivery and actual delivery data supplied in Table 18. In terms of total quantities contracted for, over the period 1943-44 all categories received more than anticipated by the allocation plan. Navy contracts amounted to approximately 25 per cent more than allocations, while Army and indirect military and civilian categories received respectively only 10 per cent and 5 per cent above allocations.

TABLE 18.—*Contracted and actual deliveries of refined copper by the Metals Distribution Control Company, fiscal years 1943–44*

[In metric tons]

Recipient	1943		1944	
	Quantity	Per cent	Quantity	Per cent
Army	36,681	31	18,970	15
Navy[1]	64,110	54	51,855	40
Indirect military and civilian	17,765	15	31,335	24
Aircraft	(2)		26,606	21
Total contracted deliveries	118,556	100	128,766	100
Total actual deliveries	120,036	100	133,975	100

[1] Includes shipping category.
[2] Included in Army and Navy allocations until 1944.

Source: Metals Distribution Control Company (Kinzoku Haikyu Tosei Kaisha), November 1945.

Quantitative data with respect to end-uses of copper are meager. However, figures obtained from the Navy account for more than one-half of Japan's copper supplies; these appear in some detail in Appendix Table 47. More than 50 per cent of the Navy's copper went to the production of guns, bombs, mines, and ammunition, while about 30 per cent went into electrical equipment and engines.

Two further fragmentary indications of the end-uses of copper are available. According to the Mining Control association, the following breakdown appli-

cable to 1942 accounts for the use of copper allocated to indirect military and civilian uses:

Use	Per cent
Electric wire	57
Copper pipe, sheet, bar, etc.	26
Other (including castings)	17

Finally the Metals Industries Control association submitted the following as the annual amounts of copper used in all wire: 1941—13,600 tons; 1942—16,600 tons; 1943—17,700 tons; and 1944—19,200 tons.

V

ATTEMPTS TO ALLEVIATE THE COPPER SHORTAGE BY SUBSTITUTION

Copper gave the Japanese more concern than any of the other non-ferrous metals. Chief shortages were reflected in the production of wire cable and in sheet brass for cartridge cases. Several attempts were made to substitute other materials in the manufacture of these produets and also in brass and bronze castings.

Aluminum was substituted with considerable technical success in wire cable. According to estimates of the Bureau of Mines, in 1942-43 this effected a 20 per cent saving of copper. Figures supplied by the Metals Industries Control association of the amount of aluminum used in wire are as follows: 1940—1,075 tons; 1941—5,098 tons; 1942—3,650 tons; 1943—3,457 tons and 1944—2,028 tons. It is apparent, however, that the tonnage of copper saved in this manner was not great. Aluminum was not substituted for copper wire used in radio, radar, and range-finders and wire for these purposes was particularly short. Used with partial success for a time, aluminum itself became short in 1944 and substitution was discontinued.

Research was pushed on the possibility of substitution of steel for copper by the Navy Technical department. First, carbon steel and stainless steel were used as copper substitutes for certain parts used in shipbuilding and engineering. Later, stainless steel was used in ordnance parts, especially copper-alloy torpedo parts. Transition within the Navy to steel cartridge cases was under way; among the cases in which steel was substituted for copper were those used in the 25 mm MG and the 12 cm high-angle gun. Captain YOSHIDA, H., attached to the Bureau of Military Affairs, Navy Department, in discussing this question, stated that the substitutes were useable, but far from completely satisfactory. This was partly due to the poor quality of steel available, and by the end of the war substitution had reached a rate of only 2-3 per cent.

Data available from Army arsenals indicate that the Army had made considerable progress in its use of steel as a copper substitute. By the outbreak of the war steel fuzes were being widely produced and used without adverse effects. Manufacturing methods had been perfected for small calibre steel cartridge cases of all makes. Research was progressing on further substitutions in cartridge cases, and on the use of mild steel for clips and holders. In 1942 the Japanese were capable of substituting steel cases for several types of field guns, ranging in calibre from 37mm to 105mm. Continued research and tests in the following year led to the conclusion that for some guns steel cases were very satisfactory. Also in that year a method for mass production of connection steel cartridge cases was established.

Research continued on the use of various types of iron and steel for cartridge cases and on the improvement of methods for their manufacture. Research still uncompleted at the war's end, was directed toward methods of producing satisfactory steel cartridge cases for use in aircraft guns. Steel cases for cartridges used in completely automatic weapons were never satisfactorily developed.

In addition to the use of steel alone, brass-coated steel cartridge cases were widely used in small arms. Japanese Army research reports for 1945 state that it had been found possible to use low-grade copper and zinc for cartridge cases, and studies had been made of their use in 7 cm AA ammunition.

Both Army and Navy research departments had studied the use of sintered iron for rotating bands on projectiles. Army reports state that these had been applied to 47 mm. and 75 mm. shells, but that the effect of their use on the durability of gun barrels had not been tested. Survey personnel observed a considerable quantity of shells equipped with iron rotating bands stored in arsenals, but it appears that few had been used.

THE EFFECT OF AIR ATTACKS ON THE COPPER SMELTERS AND REFINERIES

No planned or sustained air attack was made against the copper smelting and refining industry. As a result of aircraft bombing targets of opportunity five attacks were made against two copper refineries by aircraft of the Fifth and Twentieth Air Forces, involving a total of only 28 tons of bombs on the two refineries. Hits were scored during four of the raids against one of the refineries. In addition, the industry suffered hits on 11 other occasions as a result of spillage during raids against other installations, urban area raids, and in general-area attacks on port and harbor facilities by Navy carrier planes. One refinery was slightly damaged by naval bombardment.

Appendix Table 2 tabulates the attacks and indicates the more important damage done on each occasion. Table 19 summarizes the position in the industry of refineries and smelters damaged as a result of direct attacks.

TABLE 19.—*Copper smelters and refineries damaged by direct attack*

Company	Plant	Dates hit (1945)	Position before attack		
			Relative position in the industry, Japan proper		Ratio of production to capacity[1]
			Percentage of total capacity March 1945	Percentage contribution to total production March 1945	
East Asia Mining and Industrial Company	Miyako refinery	9, 10 August	4	5	23
Japan Mining Company	Hitachi refinery	17, 19 July	14	17	34
Japan Mining Company	Saganoseki refinery	18 March; 28 April; 10, 14 May; 22 June; 25, 28 July; 14 August	16	17	54
Mitsubishi Mining Company	Osaka refinery	1, 7, 15 June	14	7	36
Ishihara Industrial Company	Yokkaichi smelter	26 June	na	8	na

na Indicates data not available.

[1] Percentages are taken as of the first month preceding attack except in the case of Saganoseki; it is taken as of March since no damage was inflicted in the first attack.

Source: Appendix Table 2.

The four refineries attacked represented approximately 48 per cent of total refining capacity and contributed 46 per cent of total production. As the capacity of one of the refineries (Miyako) was unimpaired by attack, and that of another (Osaka) damaged to the extent of less than 50 per cent, total nominal capacity put out of operation by attacks approximated 36 per cent. The single smelter attacked contributed eight per cent to total smelter production and, while accurate figures are not available, probably accounted for approximately the same percentage of total capacity. Following the industry pattern, it was no doubt operating at less than full capacity.

The copper plants were in all cases attacked in the period following mid-March 1945. However, no serious impairment of smelting or refining plant capacity occurred prior to the 26 June attack on Yokkaiichi. Capacity utilization had progressively declined after September 1944, and at the time the attacks began the industry was operating at probably no more than 50 per cent of its capacity. As a result of the raids, however, nearly all plants which suffered direct physical damage also suffered indirectly through the destruction of housing, transportation, and power facilities. Damage to transportation—both local and general—was particularly serious, since it affected coal and raw material supplies. Destruction of housing caused temporary loss of manhours, and it also created an additional labor shortage by inducing greater absenteeism and flight to the countryside.

From the standpoint of strategic effect, the air attacks, coming as late as they did, actually had little effect on the industry. The reduction in output of the damaged plants was not noticeable in a lessened supply of finished goods. However, the industry was quite vulnerable to attack, particularly at the refining end, since only nine plants accounted for more than 95 per cent of capacity and production. Five of these each with a capacity in excess of 20,000 tons, accounted for 75 per cent of total capacity. Furthermore, the plants were accessible, and experience has proven them easily capable of being damaged. Had air strikes been made against those five plants in January when they first came within range, it is apparent that a relatively small effort—probably only slightly greater than that actually made against the industry—could, if successful, have reduced capacity well below that then being utilized. In view of the state of disrepair into which the industry had fallen, transportation bottlenecks, lack of labor and repair materials, power, fuel and subsidiary raw material shortages, it is doubtful if nominal capacity remaining after such attacks could have been fully operated. For the same reasons, capacity affected by

such raids could have been restored during the war only with great difficulty, and perhaps not at all.

The degree to which air-raid damage would have been reflected in reduced output of finished goods and the time at which it would have become effective would depend largely upon the severity of the raids and the existing level of copper stocks, working inventories, and goods in process. Copper ingot stocks in the hands of the Metals Distribution Control company, Army and Navy were probably no larger than 40,000 tons in January 1945 and by the end of the war had been further reduced to about 30,000 tons, nearly all held by the Navy. Such stocks, however, are equal to 30 to 40 per cent of reported 1944 production. No data are available on stocks of ingot or work in process in the hands of fabricators, but because of the general shortages of supply, it is unlikely that they could have been sizable. Working inventories also were no doubt inconsequential in size. It is estimated, however, that the copper pipe line in Japan contained quantities sufficient to lead the production of finished end-products by five months on the average.

On the basis of the foregoing, it accordingly appears that even had 100 per cent of Japan's capacity to produce electrolytic copper been destroyed in January 1945, and neither replaced nor repaired, stocks of metal available plus the existing pipe line would have enabled her to produce finished goods for nearly a year at a rate at least as high as that made possible by the level of output of refined copper at the beginning of the period. It may be concluded, therefore, that destruction of refining capacity would not have been reflected in a substantial further weakening of the Japanese position before January 1946; thus copper refineries and smelters were not strategic targets.

LEAD

I

STRATEGIC IMPORTANCE OF LEAD

Lead has certain unique and irreplaceable uses in modern industry; its high ductility, low melting point and corrosive resistant properties make it both easy to fabricate and desirable for pipe, sheet and cable sheathing, and essential in chemical processing. It has an important and large consumption in sulphuric acid storage batteries. The low melting point of lead-tin alloys makes them the most adaptable solder metal. Other significant uses of lead are as a basic constitutent (with copper, tin or antimony) of alloy anti-friction bearings, as the core of bullets, as type-metal, and since lead is the heaviest common metal, as a concentrated weight in such forms as submarine ballast.

Data obtainable in Japan on lead, as was also the case for zinc and tin, were far from complete for both the prewar and war periods. Persistent search disclosed that many of the records relating to the industry in the offices of the Bureau of Mines, Ministry of Commerce and Industry, had been burned in the Tokyo fires and that a similar proportion of industry records throughout Japan had been burned. Information was therefore gained from both government and industry and from the recollections and personal files of various officials. Every effort has been made to verify and check the data and they are believed to be as complete as possible under the circumstances, but it should be noted that there are some elements and some time periods missing.

II

PRE-PEARL HARBOR LEAD POSITION

1. *Domestic resources*

Japan possesses some lead-bearing ore deposits and has actively worked them for many years. They have always been insufficient, however, to provide more than a small part of total requirements so that dependence on imports has been high. No important mines have been opened for a long period, and the older workings have little potentiality for more intensive exploitation. Additional resources existed on the mainland in Korea and Manchukuo.

2. *Capacity*

By tripling refinery capacity between 1935 and 1941, at the outbreak of war, Japan had a capacity that was well balanced between smelters and refineries and was adequate to handle the greatest quantity of raw materials that would be available. That balance depended on the inclusion of the smelting capacity (about 13,000 tons) of Korea, however, for, assuming that at least part of the Takehara refinery was in operation at that time, Japan proper had refining capacity of around 50,000 tons and smelting capacity of only 36,000 tons.[1]

In Manchukuo the first five-year plan, initiated in 1937 and to have been completed in 1941, realized a four-fold increase in lead production which was made possible through the expansion of lead mines and processing facilities. By late 1941 Manchukuo possessed at least 5,000 tons of smelting and refining capacity, as partial completion of a plan for a larger balanced capacity.

Japan's total capacity of about 50,000 tons, not taking into consideration the small and independent resources of Manchukuo, but including Korea, was considerably larger than required by the development of domestic resources of ore. It was, in fact, 35 per cent greater than the highest wartime production rate of crude and refined lead. Moreover, capacity would have fallen little short of meeting the highest rate of consumption of lead.

3. *Production*

Mine production in Japan proper in 1941 was only about 15,000 tons, or 28 per cent of the average annual consumption during the war (Appendix Table 53). Because of this inadequate rate of domestic production, for some years it had been necessary for Japan (1) to make use of home-island

[1] Metric tons of metal content are used throughout unless otherwise noted. References to years are to the Japanese fiscal year.

excess smelter capacity and refining capacity by importing concentrates, (2) to make use of domestic excess refining capacity by importing crude lead and (3) to import refined metal for direct use.

4. *Imports*

Japan had resorted to all three practices; small amounts of concentrates were imported from Manchukuo and Korea, and the Japan Mining company brought crude metal smelted in its plant at Chinnampo, Korea, to its refinery at Saganoseki, Kyushu. During both 1940 and 1941, more than 10,000 tons of crude metal were brought by this route to Japan. But the third form of importing was the principal source of lead. Up to the outbreak of war refined metal imports from Canada, the United States and Mexico gave Japan the bulk of what she needed (Table 20). In the three year period 1939–40–41, Japan imported 271,000 tons of refined lead. This large amount was obtained despite decreasing availability of metal in 1940 and 1941 and the increasing restrictions on exports that became effective in the United States, Great Britain, Canada and Australia. The effect of the embargoes, however, was cushioned in 1940–41 by the fact that Japan was able to obtain 96,000 tons from Mexico and Burma.

5. *Dependence on imports*

By comparing Japanese imports of concentrates, crude and refined metal with the total receipts, Japan's prewar dependence on imports clearly appears.

TABLE 20.—*Imports of lead ingot into Japan proper, by country of origin, fiscal years 1939–41*

[In metric tons]

Year	United States	Canada	Mexico	Burma	Others	Total
1939	38,279	42,631	1,626	16,818	1,449	100,803
1940	26,626	26,366	21,559	7,367	10,173	92,091
1941	8,159		58,157	9,268	2,948	78,532
Total	73,064	68,997	81,342	33,453	14,570	271,426

Source: Appendix Table 61.

TABLE 21.—*Comparison of lead imports and total receipts in Japan proper, fiscal years 1939–41*

[In metric tons]

Year	Total imports (concentrates, crude, refined)	Total receipts (domestic plus imported ingot)	Percent of total receipts represented by imports
1939	108,502	115,025	94
1940	102,291	115,622	88
1941	89,032	105,266	85

Source: Appendix Table 50.

6. *Consumption and stock*

A further comparison between total receipts and consumption discloses the fact that by no means all that lead was being consumed, but that a sizable stockpile of metal was being built up. On Pearl Harbor day Japan had on hand nearly 100,000 tons of lead ingot. Against a prewar annual consumption of an estimated 80,000–90,000 tons, even this stock was to prove none too adequate.

III

THE WAR PERIOD SUPPLY

1. *Production*

The total supply of lead ingot available to Japan proper declined throughout the war. Production in Japan proper plus imports failed to match consumption annually by more than 20,000 tons. To the extent of that amount the stockpile had to be depleted each year. Production in Japan proper, on the other hand, maintained a fairly constant increase until September of 1944. This general increase is analyzed in the following sections.

a. *Mining.* The mining of lead in Japan proper reached its peak in the year 1943 when a total of 22,706 tons were produced. The rate of production was built up gradually throughout the war, reaching peaks (in tonnage of concentrates) in September 1943 and September 1944 (Appendix Table 54). Subsequent to both of these peaks, production fell away, and after September 1944 production never gave any indication of recovery. The final decline was caused by wasteful and unscientific working of mines, shortages of explosives, pine oil and other concentrating agents and increased labor problems. Mined lead declined to 17,344 tons in 1944, then reached an annual rate of about 12,000 tons, estimated on the basis of the April-August 1945 production data.

b. *Smelting.* Crude lead production in Japan proper kept pace with mine production throughout the war. From 15,507 tons in 1941, production rose to more than 21,000 tons in 1943, maintained a rate of 20,000 tons in 1944, and then collapsed to an

annual rate of about 10,000 tons on the basis of the last few months of the war (Table 22). The fact that in 1943 the output of crude lead exceeded ingot production is explained on the grounds that part of the crude lead was not refined that year, but was sold for direct consumption.

TABLE 22.—*Production of crude and refined lead in Japan proper, and imports of crude lead from Korea, fiscal years 1942–45.*

[In metric tons]

Year	Crude lead produced in Japan proper	Crude lead imported from Korea	Total crude receipts in Japan proper	Refined lead produced in Japan proper
1942	16,489	[1] 8,200	24,689	25,832
1943	21,236	16,100	37,336	32,031
1944	20,227	14,200	34,427	34,930
1945 (April–July)	3,105	[1] 924	4,029	4,099

[1] Shipments from Chinnampo smelter only.

Source: Appendix table 50.

As indicated in the above table, Japan was thus deriving 30–45 percent of its crude lead from Korea. While development of Korean production was an important achievement, it was inadequate to free Japan's basic industries from their inherent vulnerability.

c. *Refining.* Like the smelters, the refineries in Japan proper maintained an upward production trend until September 1944, the same month that mine and smelter production hit their peaks. During the four months immediately following, production fell away gradually, and beginning with the month of February the decline was fairly rapid. There was no unusual accumulation of crude metal at the refineries; what was available was quickly refined.

d. *Manchukuo.* Lead production in Manchukuo did not meet expectations. As shown in Table 23, production of both concentrates and ingot in 1943 did nothing more than maintain the 1942 production rate.

TABLE 23.—*Lead concentrate and ingot production in Manchukuo, fiscal years 1942–44*

[In metric tons]

Year	Concentrates	Ingot
1942	11,867	4,654
1943	10,726	4,607
1944	na	[1] 2,208

na Indicates data not available.
[1] Probably includes no more than 8 months' production.

Source: From a report submitted to the 86th session of the Japanese Diet.

2. *Imports*

a. *Ingot.* Japan's overseas sources of refined lead during the war were Burma, Manchukuo and China, with the first by far the most important. One of the principal benefits resulting from their drive into Burma was the lead resources of the country, including the Namtu smelter and refinery, which had capacities of 100,000 tons and 93,000 tons, respectively. When the Japanese gained possession of the plant in April 1942, they acquired about 30,000 tons of lead ingot which had been left on the spot. Between then and February 1945—when the Japanese abandoned the place—all 30,000 tons were carried away. Of that amount, however, only about 11,000 tons reached Japan. There may be included in that figure the 1,000 tons which had been refined there from local stocks of crude lead and represented the total production during the entire Japanese occupation, according to intelligence investigations carried on after the area had been evacuated by the Japanese. Manchukuo and China shipped more than 6,000 tons of lead ingot to Japan in the course of the war years. Of total Japanese wartime imports of lead ingot, 85 percent reached Japan by March 1944; all imports ceased by the end of December 1944.

b. *Concentrates and crude lead.* Between 3,000 and 4,000 tons of concentrates, representing 86 per cent of Japan's total wartime imports of concentrates, were brought from Manchukuo in the single fiscal year 1942. Outside of these official import figures there is some evidence that the Navy seized certain Manchukuoan concentrates in 1944, but the amount was not large. In fact, the import of concentrates did not constitute a significant wartime source of Japanese lead. Some 14,000 tons of concentrates were produced in Burma during the occupation, but none could be shipped home. Crude lead imports from Korea continued, as shown earlier, through the war as a source essential to any equilibrium in Japanese lead production.

3. *Scrap*

In 1943 some 3,174 tons of scrap and in 1944 a total of 28,624 tons were collected as part of a special scrap drive. The large figure for 1944 was chiefly the result of a government order to remove and scrap the lead linings of the staple fiber baths in the textile industry. Of lead scrap collected, it was estimated by the Bureau of Mines that eventually about 20 per cent went to refineries for re-refining, that 50 per cent went to remelt, and that 30 per cent was well sorted and distributed as scrap to foundries and other fabricators for direct use.

4. *Stocks*

The stockpiling of lead was entirely in the form of ingot; concentrate and crude metal supplies were not more than operating inventories. The stock of 100,000 tons with which Japan began the war was drawn down steadily in the course of the war years to a level of 29,000 tons at the date of surrender. Without the 71,000 tons of lead imported before and consumed during the war, Japan would have found herself in a situation of desperate scarcity.

IV

THE WAR PERIOD USE

1. *Administrative controls*

Lead, both before and during the war, was subject to the same controls as other non-ferrous metals. Details of the control system have been given in the section on copper.

2. *Distribution*

a. *General.* Consumption data for lead for the full period of the war could not be obtained in Japan because of the destruction of records. Consumption over the period 1 April 1942 to 15 August 1945, however, is known to have aggregated about 185,500 tons. Of that amount, as indicated above, 71,000 tons were drawn from stocks, and the remaining 114,500 tons represented the sum of production and imports.

Allocations for the same period are not fully available, but they can be tabulated for the period from 1 July 1942 to 31 March 1945. A summary of allocations to major consumer categories for that period is shown in Table 24.

TABLE 24.—*Allocations of lead to principal consumer categories, 1 July 1942–31 March 1945*

[In metric tons]

Category	Amount
Army	30,215
Navy	61,605
Aircraft	[1] 11,497
Indirect military and civilian	32,027

[1] Fiscal 1944 only; includes both Army and Navy aircraft and "special use".

Source: Appendix Table 64.

It is apparent that consumption during the war fell to an average of a little more than 54,000 tons per year as against the prewar rate of 80,000–90,000 tons. The changing rate at which the distributed lead was being consumed in the course of the war is estimated in Table 25.

b. *Specific.* Details of the specific use by the two largest consumers of lead—the Navy and the "indirect military and civilian categories", accounting for

TABLE 25.—*Consumption of lead in Japan proper, fiscal years 1942–45*

[In metric tons]

Year	Quantity
1942 (October–March)	24,969
1943	42,570
1944	49,355
1945 (April–July)	[1] 11,125

[1] Deliveries to Army in July are incomplete.

Source: Appendix Table 67.

75 per cent of total consumption—are shown in Appendix Tables 65 and 66. The Navy used nearly 90 per cent of its lead receipts for "electrical equipment"—principally batteries made almost entirely of lead—with most of the remainder going to shipbuilding. But the amounts received by the Navy never kept it from being hard pressed for lead throughout the war, and particularly toward the end. The stepped-up submarine program was the cause of the frequently-referred-to lead shortage, according to Yoshida, H., Navy captain and chief of the Second Division Military Affairs bureau, an important figure in the allocation of base metals.

Indirect military and civilian uses were more broadly distributed. It is notable that the metal and chemical industries took 53 per cent of total specific industrial allocations. In 1942 lead was used in the forms shown in Table 26 by the indirect military and civilian recipients.

TABLE 26.—*Pattern of indirect military and civilian lead consumption, fiscal year 1942*

Form	Per cent
Lead pipe and plate	32
Cable	17
Battery	15
Chemical and medical	8
Anti-friction metal	5
Solder	4
Type metal and printing	3
Joint	3
Hard lead	2
Other	11
Total	100

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

V

THE EFFECTS OF STRATEGIC ATTACK

1. *Direct damage*

Only two lead plants were subjected to air attack. The first—the Saganoseki, Kyushu, refinery—was undamaged, although the associated copper plant there did suffer. The second—the Hosokura smelter and refinery in northeastern Japan, which accounted for 22 per cent of refinery capacity—was not hit until the carrier-based sweep of 10 August 1945. Partial production was soon restored, and Japanese engineers estimated that only 40 days would have been required to complete repairs.

2. *Attack by blockade*

The most important influence on Japan's decreasing supply was the air-sea severance of shipping lanes to lead sources in Burma. Had transportation been no problem, Japan could have tapped the Burmese reserves and, at least, could have moved all of the 30,000 tons captured instead of only 11,000 tons. In addition, they might have moved the 11,000 tons of concentrates produced during the occupation. Korean lead was, of course, virtually immune to shipping difficulties until near the very end.

3. *If lead had been attacked earlier*

Considering Japan's lead supply position, it is clear that at no time was the industry worthwhile as an objective of strategic air attack. Stocks of lead, plus that already in the pipeline, would have protracted the period before the effect would have been felt at its maximum to more than nine months from the completion of a successful campaign. Japan could have meanwhile instituted more effective rationing of the remaining supply of refined lead.

VI

CONCLUSIONS

Japan's wartime lead position—like that of tin—was not as tight as copper, but was tighter than zinc. Lead supplies for the Navy's submarine program was the chief concern of the responsible officials, but there is no evidence that lack of lead at any time actually interfered with the operation of the underwater fleet. At least in lead, Japanese planning before the war had been carried out to the point of safeguarding the nation's requirements for a long war. The position could have been even further bulwarked by a modest application of shipping to get more of the large windfall stock of lead out of Burma.

ZINC

I

STRATEGIC IMPORTANCE OF ZINC

A widely used metal in peacetime, zinc has certain war uses that make it very nearly indispensable. It is alloyed with copper to form various brasses and bronzes, the most important of which is cartridge brass. Despite Japan's considerable success in substituting steel in shell and cartridge cases, by far the largest part continued to have to be made of brass. Zinc's notable anti-corrosion and galvanic properties make it the most effective protective coating for steel, while the latter property accounts for its exclusive use in dry cells. Zinc base alloys are used as die castings, and as an alloy with magnesium, and with aluminum in some newer alloys, it contributes importantly to the high-strength light metals. Finally, zinc has important non-metallic uses—as zinc oxide it is incorporated as a filler in rubber, and it is widely used as a white pigment. For those applications it can be, and generally is, processed directly from concentrates rather than from the metal.

As was the case with the other non-ferrous metals, statistics on zinc for the prewar and war periods found in Japan were lamentably incomplete. The offices of the Bureau of Mines, the Mining Control association (KOZAN TOSEI KAI), and the Metals Distribution Control company (KINZOKU HAIKYU TOSEI KAISHA), central organizations of the non-ferrous metals industries, were all burned out several times. What data were obtained came from industry and government and from the personal files and recollections of numerous officials. It should be noted that data for some time periods and certain series of statistics are not available, although it is believed that a fair and accurate over-all view of the zinc position can be presented.

II

ZINC IN JAPAN BEFORE THE WAR

1. *Domestic resources*

Contrary to the situation prevailing in most metals, Japan possessed considerable domestic zinc resources. The deposits were fairly large, of respectable quality, and not difficult to mine. The industry had been organized in recent years along lines similar to European practice. Mine production was expanded under rational over-all planning on a considerable scale; in 1932 output was approximately 15,000 tons, and by 1940 the national production had increased to about 57,000 tons.[1]

2. *Domestic production and capacity*

The development of zinc production in Japan proper rose steadily through the decade preceding the war. Slab zinc output in 1941 was double that of 1935, but the proportion of total output coming from domestic resources was three times that of the earlier year. Again this contrasted sharply with performance in other non-ferrous fields, for it represented the exploitation of relatively plentiful local resources and the planned building of an industry considered essential to the integrated economy.

Refining capacity for zinc was expanded in step with the increase in mine output.[2] Facilities in Japan proper were enlarged and new plants built, which, from 1935 to 1941, raised processing capacity by 56 per cent; new capacity was installed at Chinnampo, Korea, to handle ore from deposits which had been discovered in that country, and that refinery went into production in 1941. Manchukuo also played a part in Japan's plans, and a plant was

[1] Metric tons of metal content are used throughout; references to years are to the Japanese fiscal year (1 April to 31 March).

[2] It should be noted that the terms "refining" and "smelting" are used in the Appendix Tables to indicate different processes of producing finished slab zinc (the first referring to the electrolytic process for pure zinc, the second to the Belgian retort distillation process); but in textual discussion "refining" is used to apply to all slab zinc production.

started there at Koroto, Chin Chow province, to refine local ores. But the process selected was the patented American vertical retort process for zinc of especially high purity. The American engineers supervising the construction had to leave before the plant was finished, and operations were never begun.

The growth of slab zinc capacity in Japan proper and Korea over the seven years before the war is shown in Table 27. As indicated in the table, the combined capacity of the two countries was enlarged by 75 per cent between 1935 and 1941.

TABLE 27.—*Slab zinc capacity in Japan proper and Korea, fiscal years 1935–41*

[In metric tons]

Year	Japan proper		Korea	Total
	Distilled	Electrolytic	Electrolytic	
1935	34,200	10,000	.....	44,200
1936	34,200	13,000	.....	47,200
1937	40,200	19,000	.....	59,200
1938	41,100	19,000	.....	60,100
1939	44,100	22,600	.....	66,700
1940	46,100	22,600	.....	68,700
1941	46,400	22,600	8,400	77,400

Source: Appendix Table 69.

3. *Imports and their significance*

Despite a relatively favorable inherent zinc position, Japan's use of the metal was such that she was far from independent of imports in the prewar era. Although the degree of that dependence lessened measurably in the late 1930's, Japan continued to import substantial quantities of zinc for as long as possible with the obvious intent to build as large a stockpile as could be accumulated. The relationship of domestic production to imports is indicated in Table 28.

TABLE 28.—*Comparison of imported and domestic sources for zinc, fiscal years 1935–41*

[In thousands of metric tons metal content]

Year	Imports of slab zinc	Imports of zinc concentrates [1]	Domestic production of zinc concentrates [2]	Total annual receipts	Per cent imports to total receipts
1935	32.7	12.9	18.5	64.1	71
1936	42.0	12.1	25.7	79.8	68
1937	37.1	5.0	30.4	72.5	58
1938	28.0	4.2	34.3	66.5	48
1939	58.2	3.5	30.9	92.6	67
1940	23.5	8.4	56.7	88.6	36
1941	6.3	6.8	63.8	76.9	17

[1] Prior to 1943 only imports of Mitsui Mining company are included, estimated at 75 per cent of total.
[2] Includes production of only the two largest mines prior to 1940.

Source: Appendix Table 68.

It is evident that Japan's imports were of declining and almost negligible importance in the latter years of the period covered by Table 28 except as a source of zinc which could be stockpiled. From a dependence of 72 per cent on imports in 1935, Japan, through domestic development of the industry, reduced her reliance on outside supplies to only 36 per cent by 1940, exclusive of the consideration of stockpiling. The exception in 1939 can be attributed to anticipation of the imminent closing of world markets to Japanese buyers.

Imports of zinc concentrates, never amounting to more than 29 per cent of total zinc imports until 1941, came principally from Australia, China, and Indo-China. Slab zinc was purchased in a number of countries. The prewar importance of the several sources is shown in Table 29.

TABLE 29.—*Sources of slab zinc imports to Japan proper, fiscal years 1935–41*

[In metric tons]

Year	United States	Canada	Australia	Others [1]	Total
1935	7,710	10,739	10,000	4,435	32,884
1936	7,639	14,599	13,258	6,534	42,030
1937	4,735	6,485	9,671	16,195	37,086
1938	2,420	8,234	4,917	12,443	28,014
1939	11,353	22,477	8,098	16,291	58,219
1940	19,725	758	3	2,987	23,473
1941	1,551	25	.....	4,743	6,319
Total	55,133	63,317	45,947	63,628	228,025

[1] Including Poland (and Danzig), and Mexico as important sources.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

4. *Prewar consumption*

Precise data on the consumption of zinc in Japan could not be obtained. However, the available evidence indicates that approximately 65,000–70,000 tons per year were used in 1935–36, the amount rising quite rapidly in keeping with increased supplies until an estimated 85,000–90,000 tons were consumed in 1940. Prewar use of zinc followed a quite predictable pattern. While again no detailed breakdown can be given, no evidence was uncovered which indicated that Japan had departed markedly from occidental patterns in her use of zinc, although technicians interviewed admitted that the use of zinc-base die castings was not developed to its maximum.

5. *Zinc stock piles at December 1941*

Because of the net effect of domestic production, imports and consumption in the years immediately preceding the start of the war, Japan was able to

enter the conflict with a stockpile of about 26,000 tons of zinc. That amount represented a five months' supply at the annual wartime rate of consumption. Considering the extent to which home-island capacity had been increased in the last few years, both the industry and the militarists could afford a certain degree of complacency with respect to the future insofar as zinc was concerned.

III

ZINC SUPPLY DURING THE WAR

1. *Domestic production and imports*

In the early years of the war, domestic mine production continued to expand at a rapid rate. In 1943 production of concentrates was nearly 50 per cent higher than in 1941. That year, however, represented the top performance of the industry, for, owing to the cumulative effect of the restrictive factors which operated against all of the non-ferrous mining industries—shortages of skilled labor, fuel, explosives, repair materials, and food—production turned down sharply in 1944, particularly in the final quarter of that year.

Imports of concentrates, on the other hand, which came almost entirely from Korea and Manchukuo, rose more moderately, although such shipments also reached the peak in 1943. A summary of domestic production and imports of zinc concentrates is given in Table 30.

TABLE 30.—*Annual wartime production of zinc concentrates in Japan proper, imports and total receipts, fiscal years 1941–45*

[In metric tons]

Year	Concentrate production in Japan proper	Imports of concentrates	Total concentrates available
1941	63,785	[1] 6,815	70,600
1942	85,305	[1] 6,082	91,387
1943	94,105	8,581	102,686
1944	74,939	7,187	82,126
1945 (April–June)	10,829	2,527	13,356

[1] Imports of Mitsui Mining company only.

Source: Appendix Table 68.

Burma's Bawdwin mine would have proved an important source of zinc concentrates had not the shipment been so difficult. The stockpile left by the British when the Japanese moved into Burma in the spring of 1942 was about 55,000 tons. An inspection of the site by Allied personnel after the recapture disclosed that only 4,000 tons of concentrates had been moved away in the course of the entire Japanese occupation.

Slab zinc production did not by any means keep pace with the increased output of concentrates in Japan proper. As indicated in Table 31, production of slab at home rose only very slightly from 1941 to its peak in 1943, and a comparison with Table 30 shows that the use of available concentrates through the years 1941–43 declined markedly from about 89 to 60 per cent. The primary reason for that phenomenon is a heavy increase in the production of zinc oxide and other zinc compounds directly from the concentrate. As previously noted, zinc oxide is essential as a filler in the manufacture of rubber and has a large use as a white pigment when others are scarce. Since the over-all zinc situation was not pressing, the authorities seemed unconcerned at the considerable diversion of crude zinc supplies to nonmetallic uses.

TABLE 31.—*Slab zinc production in Japan proper and Korea, and imports into Japan proper from countries other than Korea, fiscal years 1941–45*

[In metric tons]

Year	Japan proper		Korea	Imports (excluding Korea)	Total receipts
	Distilled	Electrolytic	Electrolytic		
1941	48,548	13,344	2,103	6,319	70,314
1942	47,527	13,796	6,833	3,409	71,615
1943	44,827	17,507	7,452	3,441	73,227
1944	43,284	17,673	5,475	671	67,103
1945[1]	8,966	2,947	1,527	na	13,440

na Indicates data not available.

[1] 1 April to 15 August, except for some plant data missing for later months of war.

Source: Appendix Table 68.

2. *Capacity increases*

In contrast to the nearly static production of slab zinc during the war, refining capacity maintained a steady growth which gradually introduced a substantial amount of idle facilities. No increase took place in Korea; all of the step-up in capacity was in Japan proper. The major part of the growth was in electrolytic plants, where the increase from 1942 to 1944 amounted to 66 per cent. Distillation capacity rose only about 6 per cent, but over-all refining capacity was enlarged by 25 per cent. The principal new installations were a refinery erected by the

Mitsui interests at Kamioka, Gifu prefecture, and the expansion of the Mitsubishi refinery at Naoshima, Kagawa prefecture.

TABLE 32.—*Expansion of refinery capacity, Japan proper and Korea, fiscal years 1942–45*

[In metric tons]

Year	Japan proper		Korea	Total
	Distilled	Electrolytic	Electrolytic	
1942	47,800	25,900	8,400	82,100
1943	51,800	38,500	8,400	98,700
1944	51,800	43,000	8,400	103,200
1945	51,800	43,000	8,400	103,200

Source: Appendix Table 69.

A comparison of Tables 31 and 32 indicates that refinery capacity was being used to the extent of 83 per cent in 1942, but that, owing chiefly to the added new capacity, only 64 per cent was occupied in production in 1944. After the third quarter of 1944, the distillation plants encountered increasing difficulties in operation; they reported that larger and larger quantities of iron in the concentrates shortened the lives of their retorts, while simultaneously the refractories available to them deteriorated in quality. The electrolytic refineries were less affected by operating handicaps.

IV

DISTRIBUTION DURING THE WAR PERIOD

1. *Controls*

Zinc was at all times under the same controls with respect to production and distribution as applied to copper, lead, and tin. A brief description of the control system has been given in the copper section of this report.

2. *Allocations and consumption*

Data on allocations and consumption of zinc are available for only part of the war period. However, those fragmentary data—covering the period 1 October 1943 to 31 March 1945—are nevertheless sufficient to demonstrate conclusively that at no time during the war was zinc in a critical supply position. In fact, it appears that the aggregate of actual wartime deliveries of slab zinc was fully matched by production in Japan proper and Korea.

TABLE 33.—*Zinc allocations, contracts for delivery, and actual deliveries, 1 October 1943–31 March 1945*

[In metric tons]

	Amount
a. Allocated by Munitions Ministry	104,425
b. Delivery contracts of Metals Distribution Control company	98,050
c. Actual deliveries ex-warehouse of Metals Distribution Control company	94,685

Source: Appendix Table 74, and the Metals Distribution Control company (Kinzoku Haikyu Tosei Kaisha), November 1945.

There is every reason to suppose that had it been of great importance to do so, all delivery contracts and allocations could have been met in full without strain. Stock piles, which in relation to requirements and production had been comfortable at the beginning of the war, continued to grow slowly until near the very end. One reason, of course, for the relatively easy position of zinc throughout was the more drastic limitations existing for the metals to which it is complementary, especially copper and steel. There was always enough zinc to galvanize all the steel available or to match copper in the numerous joint uses.

TABLE 34.—*Stock piles of slab zinc in Japan proper, 31 March 1942–15 August 1945*

(In metric tons)

Period	Amount
31 March 1942	26,285
31 March 1944	36,797
31 March 1945	33,614
15 August 1945	[1] 33,000

[1] Estimated. In addition, the Army held about 10,000 tons and may have had unreported stocks during the earlier periods.

Source: Appendix Table 73.

3. *Use pattern*

Zinc allocated over the fiscal years 1942–44 was, in the aggregate, divided among major consumers as shown in Table 35.

TABLE 35.—*Allocations of zinc to major consumer categories, fiscal years 1942-44*

(In metric tons)

Category	Amount
Army	58,921
Navy	86,057
Indirect military and civilian	66,697
Aircraft (1944 only)[1]	10,344
Total	222,019

[1] Prior to 1944 aircraft allocations were included under the Army and Navy.

Source: Appendix Table 74.

The Navy used the zinc it received in approximately the following manner: 56 per cent to guns and ammunition, 23 per cent to marine engines, 10 per cent for shipbuilding, and 11 per cent for electrical and miscellaneous uses. The Army used most of its zinc for cartridge brass and other brasses, and for sheet zinc for dry cells and ammunition case liners. Indirect military and civilian uses were widely diffused in the repair and expansion of other industries; the electrical and mining industries were among the largest consumers.

V

QUALITY OF JAPANESE ZINC

The Japanese industry maintained the quality of its distilled zinc at uniform and satisfactory levels (about 98.65 per cent pure), which compared favorably with American "prime western" grades. In electrolytic zinc, however, output was generally distinctly inferior to occidental standards, with serious impurities—especially lead—usually far in excess of allowable limits. Since Japanese industry did not develop to any great extent the two high-capacity production processes which depend upon extremely pure zinc—zinc-base die casting and the continuous hot-rolling of brass—no particular hardships resulted from the inferior quality of electrolytic zinc.

VI

EFFECTS OF STRATEGIC ATTACK

1. *Direct damage*

Not until 18 June 1945, less than two months before the end of the war, were any zinc plants damaged by air attack. Allied intelligence had correctly estimated that little or no serious injury could be done to the war economy of Japan via the zinc industry, and such damage as did occur within the industry resulted largely from spillage and from hits on zinc plants struck as targets of opportunity. For the record, Table 36 details the data with respect to plants, dates and capacities affected in air attacks.

Although three plants representing 45 per cent of refinery capacity and 67 per cent of current output were damaged, in no one of the plants was production stopped, and in all of the plants the damage could

TABLE 36.—*Zinc smelters and refineries damaged by air attack*

Plant	Date hit	Position before attack[1]		
		Relative position in the industry		
		Percentage of total capacity	Percentage contribution to total production	Percentage of production to capacity
Hosokura smelter	10 August 1945	13	17	34
Mike smelter	18 June; 27 July; 7 August 1945	21	40	84
Mike refinery	18 June; 27 July; 7 August 1945	11	10	41
Total		45	67	

[1] Percentages for all columns are taken as the calendar month prior to the first attack. Percentages in the first two columns refer to Japan proper only.

Source: Appendix Table 2.

have been restored in a few weeks or compensated for by manual labor.

2. *Effect of blockade*

Zinc, among the metals, stands almost alone in its invulnerability to the effects of the air-sea blockade. To be sure, zinc supplies could have been made even more comfortable if the Japanese had had free access to the resources of Burma, but that source of zinc was never necessary for the maintainance of an uninterrupted flow of the metal to important consumers. The blockade of Japan could not have seriously interfered with the working of her industrial machine through the cutting off of zinc, even if the Korean exports could have been intercepted. In the light of stocks of zinc on hand, supplies of the metal in the pipeline, and the excess capacity within the industry, there is little basis for considering, in fact, whether aerial attack in maximum strength at the earliest possible date would have proved worthwhile.

TIN

I

THE STRATEGIC IMPORTANCE OF TIN

The importance of tin to Japanese military and industrial production lay in four major uses. The first was in bearings and all kinds of anti-friction metals. Those metals contain either 85 to 90 per cent tin alloyed with antimony and copper, or are of a lead base alloyed with tin varying from 5 to 40 per cent. The second use was as a principal constituent of soft solders, which are used in engines, electrical equipment and many military products. Its third use was in tin plate where excellent resistance to corrosion makes it difficult to replace for such purposes as food preservation. The final major use was in bronze. The tin content of naval bronze is about 10 per cent.

II

BACKGROUND OF JAPANESE TIN INDUSTRY

Production and consumption of tin in Japan proper were both of very small proportions in the 1930s. Dating back to the first World War, the industry never substantially exceeded an annual production rate of about 2,000–2,500 tons.[1] Production was dependent principally on one mine (the Akenobe mine in Hyogo Prefecture some 70 miles northwest of Osaka), on one smelter (at Ikuno near the Akenobe mine), and one refinery (the Mitsubishi Copper refinery in Osaka), which received most of the crude tin from the Ikuno smelter. However, another deposit, although smaller, was located at Mitate, in Miyazaki prefecture, Kyushu. The tin mined there was smelted and refined at Oita, 30 to 40 miles to the northeast on the shore of the Inland Sea.

Consumption, which in the early and middle 1930s ranged from 6,000–7,000 tons per year, rose from 1937 to 1941, under pressure of the increasing military program, to about 10,000 or 11,000 tons. The difference between production and consumption was imported from the Straits settlements and China.

The most notable feature of the Japanese prewar tin industry was the obvious poverty of her domestic resources. No significant new deposits were being discovered; the old mines yielded regularly a small volume, but with concentrates of steadily decreasing metallic value. The purchase of new equipment for and the expansion of the Osaka refinery in 1937 and 1938 had no effect in achieving increased domestic production. It was plain that to fight a major war Japan had to have access to foreign sources of tin.

III

POSITION AT THE OUTBREAK OF THE WAR

1. *Capacity*

As Japan's mine capacity was limited and as refined metal was customarily imported, smelter and refinery capacity was accommodated to the meager tin ore resources and stood at 3,600 tons and 3,000 tons respectively (Appendix Table 79, 80).

2. *Production*

In 1941 domestic production of refined tin reached more than 2,000 tons (Appendix Table 85). This was achieved by supplementing the 1,300 tons of tin ore mined in Japan proper with tin imported as concentrate mainly from Thailand (Appendix Table 81).

[1] Tons are all metric tons of metal content; years, unless otherwise specified, are fiscal.

3. *Imports*

Although some concentrates were imported in 1941, the principal source of tin was the refined metal brought into Japan from the Straits settlements and the Dutch East Indies. The extent to which the Japanese relied on imported metal in the immediate prewar years is shown in Table 37.

TABLE 37.—*Dependence on imports of refined tin, fiscal years 1939-41*

[In metric tons]

Year	Total receipts (imports plus production)	Imports as a percentage of total receipts
1939	9,362	85
1940	12,321	88
1941	7,391	74

Source: Appendix Table 78.

Japan's plan for importing tin in 1941 was partly frustrated by the British and Dutch embargoes of that year. Metals experts of the Bureau of Mines have stated that the shortage of tin resulting from the embargoes immediately preceding the outbreak of the war was fully as severe as that experienced in 1945. However, Japan's strained tin position could be made secure by a successful campaign in Malaya and the Netherlands East Indies, and it is likely that that was one of the considerations involved in the decision to under take the southern invasion.

4. *Stocks*

At the outbreak of the war Japanese tin stocks were about 7,000 tons, or enough to last nearly eight months at the immediate prewar level of consumption. At the increased wartime average annual consumption rate of about 18,000 tons, the stocks would have sufficed for less than five months (Appendix Table 78).

IV

WARTIME SUPPLY

1. *Imports*

The successful Japanese military campaign of early 1942 in the south secured her tin position for the war. Large stocks of tin ingot were on hand in the southern areas. The first shipment reached Japan in June 1942, but tin did not begin to arrive in steady quantities until December 1942 (Appendix Table 88). During the war Japan imported a total of about 57,000 tons of tin. The last shipment from the south, about 1,800 tons, reached Japan in May 1945. The significance of wartime refined tin imports to Japan proper appears in Table 38.

TABLE 38.—*Dependence on imports of refined tin, fiscal years 1942-45*

[In metric tons]

Year	Total receipts (imports plus production)	Imports as a percentage of total receipts
1942	14,871	74
1943	28,581	94
1944	17,737	96
1945 (April-July)	(3,068)	98

( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

Source: Appendix Table 78.

2. *Production*

Once overseas supplies of tin had been obtained, domestic production was no longer greatly encouraged. Japan found it simpler to import an extra 2,000 tons of high quality ingot than to strain to achieve a maximum domestic production from inferior ores. Because of this policy, production began a steady descent in the fall of 1942. By October, mine, smelter, and refinery production had all passed the peak, from one to two years before maximum production was reached in copper, zinc, or lead (Appendix Tables 81–86).

Domestic production sagged not only because it was no longer pushed, but also as a result of other factors. Among them were (1) the inability to rely any longer on imported concentrates; (2) a decline in the metal content of the domestic concentrates from 50 per cent to 40 per cent; and (3) the general conditions that limited mine output of all metals in 1944 and 1945, such as shortages of food, labor, explosives, and concentrating reagents, and the inefficient working of the mines.

3. *Scrap*

Although small quantities of scrap were collected, normal difficulties in recovering tin from scrap precluded it as an important source of tin.

4. *Stocks*

The constant flow of imported tin kept Japan's stocks reasonably strong. At the time of surrender, an estimated 10,000 tons of tin ingot were accumulated in Japanese warehouses and arsenals.

WARTIME DISTRIBUTION

1. *Wartime controls*

Controls established during, as before, the war were for tin the same as for other non-ferrous metals. A detailed account will be found in the accompanying report on copper.

2. *Distribution*

a. *General Distribution.* The records of the Metals Distribution Control company (Kinzoku Haikyu Tosei Kaisha) indicate that a total of 61,417 tons of tin were delivered to fabricators and consumers in the period from 1 April 1942 to 30 June 1945. This is generally confirmed by comparison with the net of production plus imports less the approximate increase in stocks (Appendix Table 78). By the end of June 1945 production had virtually ceased, imports were totally cut off, and consumption thereafter was negligible.

TABLE 39.—*Allocations of tin, fiscal years 1943-44.*

[In metric tons]

Category	1943		1944[1]			
			April-September		January-March	
	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent
Army	4,932	26.5	1,821	19.4	380	11.4
Navy	7,141	38.3	3,234	34.5	705	21.2
Indirect military and civilian	6,572	35.2	2,059	22.0	798	23.9
Aircraft	(2)		2,261	24.1	621	18.7
Special					825	24.8
Total	18,645	100.0	9,375	100.0	3,329	100.0

[1] Data for October-December are not available.
[2] Aircraft allocations prior to 1944 were included in allocations to the Army and Navy.

Source: Appendix Table 90.

The total amount of tin allocated during the 21-month period for which data are available, and which is indicated in the above table, was about 31,300 tons. Distribution during the same period (Appendix Table 93) was about 1,600 tons higher. The fact that the difference between the quantities allocated and distributed is so small is evidence that the same part of the tin supply which was officially allocated was also claimed and distributed through the authorized distribution machinery (Table 39). The total amount allocated and distributed against allocations between April 1942 and August 1945 is estimated at about 46,000 tons. The difference between this figure and the approximately 60,000 tons consumed during the same period was accounted for by metal imported by the Army, stored in the Metals Distribution Control company warehouses, and drawn freely by the Army without need for specific authorization. The fact that the Army imported about 39,000 tons in the course of the war gave it a certain claim on a large portion of the tin supply even though it did not appear in the Army stock figure.

b. *Specific Distribution.* The Navy and "indirect military-civilian" categories were the largest consumers of tin throughout the war. The Navy, having been allocated 32 per cent of the total allocations for the over-all period, apparently received in fact more than 40 per cent.

Of the specific Navy uses of tin, the greatest quantity went into engines, which accounted for approximately 50 per cent of the amount consumed by the Navy (Appendix Table 91). Guns and ammunition took about 12 per cent; torpedoes and mines another 11 or 12 per cent; shipbuilding about 10 per cent; and electrical equipment 10 per cent.

"Indirect military and civilian allocations" were chiefly to the machine tool industry, presumably for bearings, and to the iron and steel industry, probably for the production of tin plate (Appendix Table 92). Tin allocated for export was evidently never shipped in view of the insignificant tin exports reported by the Ministry of Finance. The distribution of tin by end-use is shown for 1942 in the following table:

TABLE 40.—*Use distribution of tin in Japan proper, fiscal year 1942*

(Expressed in per cent)

Use	Per cent
Antifriction	31
Solder	22
Plating	21
Copper alloy	15
Others	11
Total	100

Source: Ministry of Commerce and Industry, November 1945.

The Army was not greatly concerned over tin until near the end of the war. In the spring of 1945 a special collection drive for tin was instituted, prompted by the production plans for the "Shusui", a rocket-propelled aircraft which was being designed for defense against B-29 raids. The "Shusui", which was test flown in June 1945, received 25 per cent of the total allocation in the fiscal year 1944.

VI

EFFECT OF STRATEGIC BOMBING—CONCLUSIONS

The vulnerability of Japan's tin position lay in its dependence on imports. The success of the air war as it affected the tin industry was thus almost directly proportional to the effectiveness of blockading shipments from the south. The difficulty in choking off tin, however, was that the Japanese were not obliged to import very large tonnages in order to secure their wartime supply position. With an annual average wartime consumption of about 18,000 tons, tin was not as vulnerable to the destruction of ships as were the metals that required bulk ore shipments such as steel and aluminum. In fact, what caused the cessation of tin imports was not the shortage of bottoms, but only the complete severance of shipping lanes by the Allied naval and air blockade. This is illustrated by the fact that as late as April and May, 1945 (during the battle of Okinawa) the Japanese Army succeeded in importing about 3,000 tons.

The effect of the area incendiary bombing of 15 June 1945, by which the largest Japanese tin refinery, at Osaka, was crippled for the remaining months of the war, was insignificant in its economic aspects as far as tin was concerned. Although that plant had refined 78 per cent of total domestic production, it was only operating at two per cent of capacity at the time of bombing.

ALUMINUM

APPENDIX TABLE 1.—*Directory of principal Japanese-controlled light and non-ferrous metals installations listed by industry, November 1945*

Company	Installation	Location of installation
ALUMINA PLANTS		
Japan proper		
1. Asada Chemical Industries Co.	Shikama	Shikama-shi, Hyogo-ken.
2. Dai Nippon Chemical Co.	Kawasaki	Kawasaki-shi, Kanagawa-ken.
3. Japan Aluminum Co.	Kurosaki	Higasiwari, Kumate, Yawata-shi, Fukuoka-ken.
4. Japan Light Metals Co.	Shimizu	Miho, Shimizu-shi, Shizuoka-ken.
5. Japan Soda Co.	Takaoka	Kono-machi, Takaoka-shi, Toyama-ken.
6. Kokusan Keigin Co.	Iwate	Kurosawaziri-machi, Iwate-ken.
7. Mitsui Light Metals Co.	Miike	Omuta-shi, Fukuoka-ken.
8. Nitto Chemical Industries Co.	Hachinoe	Hachinoe-shi, Aomori-ken.
9. Showa Denko Co.	Toyama	Toyama-shi, Toyama-ken.
10. Showa Denko Co.	Yokohama	Ebisu-machi, Kanagawaku, Kanagawa.
11. Sumitomo Chemical Industries Co.	Niihama	Kikumoto Niisuza, Niihama-shi, Ehime-ken.
12. Toyo Soda Co.	Tonda	Tonda-machi, Tono-gun, Yamaguchi-ken.
Korea		
13. Chosen Light Metals Co.	Chinnampo	Chinnampo, Heiannando, Korea.
14. Japan Nitrogen Fertilizer Co.	Konan	Konan, Kankyonando, Korea.
Manchukuo		
15. Manchukuo Light Metals Co.	Fushun	Fushun, Fengtien, Manchukuo.
Formosa		
16. Japan Aluminum Co.	Takao	Takao-shi, Formosa.
ALUMINUM PLANTS		
Japan proper		
1. Japan Light Metals Co.	Kambara	Kambara-machi, Ihara-gun, Shizuoka-ken.
2. Japan Light Metals Co.	Niigata	Niigata-shi, Niigata-ken.
3. Japan Soda Co.	Takaoka	Kono-machi, Takaoka-shi, Toyama-ken.
4. Kokusan Keigin Co.	Toyama	Osawano-machi, Toyama-ken.
5. Showa Denko Co.	Kitakata	Kitakata-machi, Fukushima-ken.
6. Showa Denko Co.	Omachi	Omachi, Nagano-ken.
7. Showa Denko Co.	Toyama	Nishenomiya, Toyama-shi, Toyama-ken.
8. Sumitomo Aluminum Co.	Niihama	Kikumoto Niisuza, Niihama-shi, Ehime-ken.
9. Tohoku Shinko Aluminum Co.	Koriyama	Miyata, Koriyama-machi, Fukushima-ken.
Korea		
10. Chosen Light Metals Co.	Chinnampo	Chinnampo, Korea.
11. Japan Nitrogen Fertilizer Co.	Konan	Konan, Kanyonando, Korea.
12. Mitsui Light Metals Co.	Yoshi	Yoshi, Heranhokudo, Korea.
Manchukuo		
13. Manchukuo Light Metals Co.	Fushun	Fushun, Fengtien, Manchukuo.
Formosa		
14. Japan Aluminum Co.	Karenko	Karenko-cho, Formosa.
15. Japan Aluminum Co.	Takao	Takao-shi, Formosa.

MAGNESIUM

MAGNESIUM PLANTS		
Japan proper		
1. Asahi Electrical Industries Co.	Ogu, Tokyo	Ogu-machi, Arakawa-ku, Kanagawa-ken, Tokyo.
2. Japan Magnesium Co	Toyama	Osawano-machi, Kaminikawa-gun, Toyama-ken.
3. Kanto Electrical Industries Co.	Shibukawa	Shibukawa, Gunma-ken.
4. Riken Metal Manufacturing Co.	Ube	Okinoyama, Nishi-ku, Ube-shi, Yamaguchi-ken.

MAGNESIUM—Continued

APPENDIX TABLE 1.—*Directory of principal Japanese-controlled light and non-ferrous metals installations listed by industry, November 1945—continued*

Company	Installation	Location of installation
MAGNESIUM PLANTS—Con.		
Japan proper		
5. Shinetsu Chemical Industries Co.	Naoetsu	Obuke-mura, Nakakubiki-gun, Niigata-ken.
6. Teikoku Magnesium Co.	Sakata	Sakata, Yamagata-ken.
Korea		
7. Asahi Light Metal Manufacturing Co.	Kiyo	Kiyo, Heiannando.
8. Korea Light Manufacturing Co.	Chinnampo	Chinnampo, Heiannando.
9. Korea Shinko Metal Manufacturing Co.	Shingishu	Shingishu, Heianhokudo.
10. Mitsuhishi Magnesium Co.	Chinnampo	Chinnampo, Heiannando.
11. Mitsui Yushi Chemical Industries Co.	Sanchoku	Sanchoku, Kogendo.
12. Nichitsu Magnesium Co.	Konan	Konan, Kankyonando.
Manchukuo		
13. Manshu Magnesium Co.	Eiko	Eiko.
Formosa		
14. Asahi Electrical Industries Co.	Takao	Takao, Formosa.

COPPER

COPPER MINES		
Japan proper		
1. Fujita Co.	Hanaoka	Hanaoka-machi, Kamiakita-gun Akita-ken.
2. Furukawa Mining Co.	Ashio	Ashio-machi, Kamitsu-gun, Tochigi-ken.
3. Furukawa Mining Co.	Innori	Maozu-mura, Naka-gun, Wakayama-ken.
4. Furukawa Mining Co.	Kune	Sakuma-mura, Iwata-gun, Shizuoka-ken.
5. Ishiwara Industrial Co.	Kishu	Iruka-mura, Minamimuro-gun Mie-ken.
6. Japan Mining Co.	Hitachi	Hitachi-shi, Ibaraki-ken.
7. Japan Mining Co.	Kamikita	Temmabayashi-mura, Kamikita gun, Aomori-ken.
8. Japan Mining Co.	Ogoya	Nishio-mura, Nomi-gun, Ishikawa-ken.
9. Mitsubishi Mining Co.	Akenobe	Minamitani-mura, Yofu-gun, Hyogo-ken.
10. Mitsubishi Mining Co.	Ikuno	Ikuno, Asaki-gun, Hyogo-ken.
11. Mitsubishi Mining Co.	Makimine	Kitakata-mura, Higashiusuki-gun, Miyazaki-ken.
12. Mitsubishi Mining Co.	Osarizawa	Osarizawa-mura, Kazuno-gun, Akita-ken.
13. Mitsubishi Mining Co.	Shinshimokawa	Shimokawa-mura, Kamikawa-gun, Hokkaido.
14. Showa Mining Co.	Okuki	Isozaki-cha, Kita-gun, Ehime-ken.
15. Sumitomo Mining Co.	Besshi	Niihama-shi, Ehime-ken.
COPPER SMELTERS		
Japan proper		
1. East Asia Mining and Industrial Co.	Miyako	Koyamada, Miyako-shi, Iwate-ken.
2. Fujita Co.	Kosaka	Kosaka-machi, Kazuno-gun, Akita-ken.
3. Furukawa Mining Co.	Ashio	Ashio-machi, Kamitsugo-gun, Tochigi-ken.
4. Greater Japan Mining Co.	Hassei	Hatsumori-mura, Yamamoto-gun, Akita-ken.
5. Ishihara Industrial Co.	Yokkaiichi	Ishihara-machi, Yokkaiichi-shi, Mie-ken.
6. Japan Mining Co.	Hitachi	Hitachi-shi, Ibaraki-ken.
7. Japan Mining Co.	Ogoya	Nishio-mura, Noto-gun, Ishikawa-ken.
8. Japan Mining Co.	Saganoseki	Saganoseki-machi, Kitaumibe-gun, Oita-ken.
9. Mitsubishi Mining Co.	Naoshima	Naoshima-mura, Kagawa-gun, Kagawa-ken.
10. Mitsubishi Mining Co.	Osarizawa	Osarizawa-machi-Kazuna-gun, Akita-ken.

APPENDIX TABLE 1.—*Directory of principal Japanese-controlled light and non-ferrous metals installations listed by industry, November 1945—continued*

Company	Installation	Location of installation
COPPER SMELTERS—Con.		
Japan proper—Continued		
1. Mitsui Mining Co.	Hibi	Hibi-machi, Tamano-shi, Okayama-ken.
2. Sumitomo Mining Co.	Shisakajima	Miyakuho-mura, Etsuchi-gun, Ehime-ken.
3. Sumitomo Mining Co	Kunitomi	Ozawa-mura, Iwachi-gun, Hokkaido.
Korea		
4. Japan Mining Co.	Chinnampo	Chinnampo, Heinando, Korea.
COPPER REFINERIES		
Japan proper		
1. East Asia Mining and Industrial Co.	Miyako	Koyamada, Miyoko-shi, Iwate-ken.
2. Fujita Co.	Kosada	Kosaka-machi, Kazuno-gun. Akita-ken.
3. Furukawa Mining Co.	Nikko	Nikko, Shioya-gun, Tochigi-ken.
4. Ishiwara Industrial Co.	Yokkaiichi	Ishihara-machi, Yokkaiichi-shi, Mie-ken.
5. Japan Mining Co.	Hitachi	Hitachi-shi, Ibaraki-ken.
6. Japan Mining Co.	Saganoseki	Saganoseki-machi, Kitaumibe-gun, Oita-ken.
7. Mitsubishi Mining Co	Osaka	Shinkawasaki-machi, Kita-ku, Osaka-shi.
8. Mitsui Mining Co.	Takehara	Takehara-machi, Kamo-gun, Hiroshima-ken.
9. Sumitomo Mining Co.	Niihama	Niihama-shi, Ehime-ken.

LEAD

LEAD MINES		
Japan proper		
1. Mitsubishi Mining Co.	Hosokura	Uguisuzawa, Kurihara-gun, Miyagi-ken.
2. Mitsui Mining Co.	Kamioka	Funatsu, Yoshiki-gun, Gifu-ken.
LEAD SMELTERS		
Japan proper		
1. Japan Soda Co.	Aizu	Yama-guo, Fukushima-ken.
2. Mitsubishi Mining Co.	Hosokura	Uguisuzawa, Kurihara-gun, Miyagi-ken.
3. Mitsui Mining Co.	Kamioka	Funatsu, Yoshiki-gun, Gifu-ken.
Korea		
4. Japan Mining Co.	Chinnampo	Chinnampo, Heiannando.
LEAD REFINERIES		
Japan proper		
1. Japan Mining Co.	Saganoseki	Kitaumibe-gun, Oita-ken.
2. Japan Soda Co.	Aizu	Bantai, Yama-gun, Fukushima-ken.
3. Mitsubishi Mining Co.	Hosokura	Kurihara-gun, Miyagi-ken.
4. Mitsui Mining Co.	Kamioka	Yoshiki-gun, Gifu-ken.
5. Mitsui Mining Co.	Takehara	Kamo-gun, Hiroshima-ken.
Manchukuo		
6. na.	Koroto	Koroto, Manchukuo.
7. na.	Mukden	Mukden, Manchukuo.

APPENDIX TABLE 1.—*Directory of principal Japanese-controlled light and non-ferrous metals installations listed by industry, November 1945—continued*

Company	Installation	Location of installation
ZINC MINES		
Japan proper		
1. Budo Mining Co.	Budo	Shino-machi, Niigata-ken.
2. Fujita Mining Co	Hanaoka	Odate, Akita-ken.
3. Mitsubishi Mining Co.	Ikuno	Ikuno, Asako-gun, Hyogo-ken.
4. Mitsubishi Mining Co.	Hosokura	Uguisuzawa-mura, Kurihara-gun, Miyagi-ken.
5. Mitsui Mining Co.	Kamioka	Funatsu-machi, Yoshiki-gun, Gifu-ken.
ZINC SMELTERS AND REFINERIES		
Japan proper		
1. Japan Soda Co.	Budo	Shino, Iwafune-gun, Niigata-ken.
2. Japan Soda Co.	Aizu	Bantai, Yama-gun, Fukushima-ken.
3. Japan Zinc Co.	Nakatatsu	Shimoanama, Ono-gun, Fukui-ken.
4. Kurashiki Mining Co.	Odomori	Uguisuzawa, Kurihara-gun, Miyagi-ken.
5. Mitsubishi Mining Co.	Hosokura	Uguisuzawa, Kurihara-gun, Miyagi-ken.
6. Mitsubishi Mining Co.	Naoshima	Naoshima, Kagawa-gun, Kagawa-ken.
7. Mitsui Mining Co.	Hibi	Hibi, Tamano-shi, Okayama-ken.
8. Mitsui Mining Co.	Hikoshima	Hikoshima, Shimonoseki-shi, Yamaguchi-ken.
9. Mitsui Mining Co.	Kamioka	Funatsu-machi, Yoshiki-gun, Gifu-ken.
10. Mitsui Mining Co.	Miike	Asamuta-machi, Omuta-shi, Fukuoka-ken.
Korea		
11. Japan Mining Co.	Chinnampo	Chinnampo, Heiannando.

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TIN MINES		
Japan proper		
1. Mitsubishi Mining Co.	Akenobe	Minamitani, Yabu-gun, Hyogo-ken.
2. Toyo Mining Co.	Mitate	Iwato, Nishisuki-gun, Miyazaki-ken.
TIN SMELTERS		
Japan proper		
1. Mitsubishi Mining Co.	Ikuno	Asako-guo, Hyogo-ken.
TIN REFINERIES		
Japan proper		
1. Mitsubishi Mining Co.	Mitsubishi Copper refinery, Osaka	Shinkawasaki, Kita-ku, Osaka-shi.

na Indicates data not available.

Sources: Bureau of Mines, Ministry of Commerce and Industry, November 1945 For Korean copper, lead, and zinc names—the Japan Mining company. For Manchurian lead and copper plants—the Manchurian Industrial Development company November 1945.

APPENDIX TABLE 2.—*Summary of attacks on Japanese light and non-ferrous metals plants*

Company	Plant	Position before attack[1]			Dates of and AF making specified target attacks[3]	Tonnage of specified target attacks	Dates hit (1945, except where specified)	Type of attack	Results and note
		Relative importance		Ratio of production to capacity (percent)					
		Percentage of total capacity[2]	Percentage contribution to total production[2]						
Alumina plants									
Japan Light Metals Co.	Shimizu	20	24	15	10 April 2, 25 July—20th AF	24	10 June	Urban area (HE)	Partial damage to machinery repair shop, bauxite storage house, and transformer station of alumina kiln plant. Pump room completely destroyed. Chief damage result of direct hit on thickener of red mud plant. As result of damage to water works and steam supply, production totally ceased until 19 June, when restoration accomplished. Thickener damage reduced red mud processing capacity by 30 percent.
							7 July	Urban area (IB)	Total destruction of transformer room of alumina kiln plant, exhaust fan room of gas-producing plant, storehouses and accessory rooms. Production stopped totally until 26 July, when transformer room and exhaust fan room restored.
							31 July	Naval bombardment	Chief damage by shell splinters to thickener and solution storage tanks of red mud plant, decomposition tanks, and main producer-gas pipe line. Production suspended totally. Restoration in process but not accomplished by end of war.
							2 August	Urban area (IB)	Main damage to business and transportation offices. Plant not in operation due to 31 July attack.
Nitto Chemical Industries Co.	Hachinoe	(4)	(4)	26			15 July	Carrier plane	Synthetic ammonia gas tanks and warehouse totally destroyed. Extensive damage to other buildings, but slight damage to machines and essential equipment. Insignificant existing production cut by 20 percent.
							9 August	do	Direct hit by dud bomb seriously damaged rotary kiln.
							10 August	do	Damage to storage shed.
Sumitomo Chemical Industries Co.	Niihama	13	10	10	24 July—20th AF	10	24 July	Directed attack (HE)	Chief damage to alumina calcining plant with subsidiary damage to offices and alumina storehouses. Extensive damage to roofs and walls of buildings. Alumina plant resumed production 30 July.
Kokusan Keigin Co.	Iwate	(4)	1	28			10 August	Carrier plane	Damage to 22 percent of buildings and 13 percent of equipment, with chief damage to filter plant, equipment, and piping. Production suspended. Repairs to filter equipment not completed by end of war.
Dai Nippon Chemical Co.		(4)	*d*	*d*			15 April	Urban area (IB)	Chief damage to crystalization equipment and electric substation, completely knocking out section of plant operating on clay by hydrochloric acid method. Minor damage to alunite section.
Japan Aluminum Co.	Takao	[5] 8 [6] 8	[5] 8 [5] 10	[5] 60 [6] 28	17, 18, 24 February. 1 March—5th AF	197	12 Oct. 1944	Carrier plane	Damage minor.
							17, 18, 24 February—1 March	Directed attack (HE, IB, and FR).	No detailed damage data available. Enforced complete cessation of operations. No attempt made at restoration because of extent of damage and lack of bauxite. Bauxite stocks had disappeared early in 1944. Main operation since had been recovery of alumina from red mud, mixed with sporadic receipts of bauxite. By February 1945 recovery from red mud was sole operation, and plant would shortly have been forced to shut down.

See footnotes at end of table.

APPENDIX TABLE 2.—*Summary of attacks on Japanese light and non-ferrous metals plants*—Continued

Company	Plant	Position before attack [1]			Dates of and AF making specified target attacks [3]	Tonnage of specified target attacks	Dates hit (1945, except where specified)	Type of attack	Results and notes
		Relative importance		Ratio of production to capacity (percent)					
		Percentage of total capacity [2]	Percentage contribution to total production [2]						
Aluminum reduction plants									
Japan Light Metals Co.	Kambara	23	16	8			25 July	Low-level attack	Incendiary bullets caused burning out of 2 out of 3 outdoor transformers. No production stoppage, but capacity cut by 50 percent.
							30 July	do	Remaining outdoor transformer fired by incendiary bullet. Damage to 2 electrolysis plants, cranes, transmission lines, boiler rooms, and housing. Complete production stoppage. Capacity limited by power supply to roughly 25 percent of preattack level.
Sumitomo Aluminum Co.	Nihama	15	12	9	24 July—20th AF	10	24 July	Directed attack (HE)	1 battery of electrolytic pots seriously damaged together with lesser damage to synthetic cryolite and electrode plants. Production resumed 25 July.
Tohoku Shinkō Aluminum Co.	Koriyama	2	(4)	(4)			12 April	(HE)	Spill-over from attack on Hodogaya chemical plant. Portions of current transfer house, melting plant buildings, and electrolysis plant destroyed. Capacity reduced by 30 percent. Plant had not been in production since preceding November. Restoration made by 1 July.
Japan Aluminum Co.	Takao	{5 8 6 9	{5 9 6 10	69 6 34	17, 18, 24 February 1 March	5th AF 197	12 Oct. 1944	Carrier plane	Damage minor.
							17, 18, 24 February 1 March	Directed attack (HE)	No detailed damage data available. Complete production stoppage. No attempt at restoration because of extent of damage and lack of alumina.
Do.	Kareukō	5	(3)	(4)			12, 14 Oct. 1944	Carrier plane	First salvo of rockets demolished mercury arc rectifier which would have enforced complete stoppage until replacement. However, transformers had been destroyed by typhoon in August, and plant had been out of production since that time. No effort made to restore plant, since replacement of transformers or mercury arc rectifier was impossible.
Magnesium plants									
Asahi Electrical Industries Co.	Ogu, Tokyo	3	2	30			14 April	Urban area (IB)	No damage to plant or equipment. Destruction of lodging area forced plant to close for lack of labor.
Kanto Electrical Industries Co.	Shibukawa	14	10	27			30 July	na	Transmission lines cut, offices burned, and soda electrolysis and hydrochloric acid plants damaged. Production was probably stopped, although no data for August is available.
Riken Metal Manufacturing Co.	Ube	15	8	20			2 July	Urban area (IB)	Soda electrolysis building, warehouse, and converter burned. No damage to magnesium plant. Production continued.
							22 July	Spill-over from raid on Ube Coal Liquefaction plant (HE).	Main water main broken; could not repair for 24 days due to pipe shortages. No other damage to magnesium plant. Production stopped.
Teikoku Magnesium Co.	Sakata	7 6	7 5	7 16			30 June	na	5 bombs dropped in yard. No damage to plant or equipment. Production continued.
							10 August	Carrier plane	2 bombs dropped in yard. 1 damaged 2 buildings. No damage to equipment. Production not affected by raid.

See footnotes at end of table.

APPENDIX TABLE 2.—*Summary of attacks on Japanese light and non-ferrous metals plants*—Continued

Company	Plant	Position before attack [1]			Dates of and AF making specified target attacks [3]	Tonnage of specified target attacks	Dates hit (1945, except where specified)	Type of attack	Results and notes
		Relative importance		Ratio of production to capacity (percent)					
		Percentage of total capacity [2]	Percentage contribution to total production [2]						
Copper plants									
East Asia Mining and Industrial Co.	Miyako copper refinery.	4	[8]5	23			9 August	do	Plant strafed. Fires started but no serious damage.
							10 August	do	Plant strafed and bombed. Damage to sulfuric acid; plant required 2 weeks repair. Damage to electrolytic plant slight and operations not suspended. After raid, owing to break-down of subsidiary machinery, operation suspended for 2 months. Break-down probably not directly due to raids.
Japan Mining Co.	Hitachi copper refinery.	14	[8]17	34	26 July—20th AF	5	17 July	Naval bombardment	Plant damaged only slightly, but company officials state bombardment contributed to success of subsequent air attack.
							19 July	Urban are (HE and IB)	All electrolytic cells destroyed and consequently refining capacity. Reverberatory furnace damaged. Electric railway damaged in places. Ore crushing and sampling plant, 3 electric locomotives, and 129 ore cars destroyed. (Probably small installation below the town where ore shipped in was received. USSBS observers found no damage to smelter or mining equipment used on Hitachi ore.) Plant officials estimated a maximum of 30 percent recovery after 6 months of production and 50 percent after a subsequent 6 months' period of gradually increasing production. Plan formulated to bring in excess refining equipment from the Saganoseki refinery.
Japan Mining Co.	Saganoseki copper refinery.	16	17	54			18 March	na	No damage.
					28 April—20th AF	[9]2	28 April	Directed attack (HE).	Damage to hall. Not important to production. Repairs estimated to be finished 20 February 1946.
					10 May—20th AF	[9]3	10 May	do	One 120-ton boat sunk. Five 150-ton barges sunk. Repairs estimated to be finished 10 June 1946.
							14 May	na	Small building unrelated to production damaged. Finished repairs 15 July 1945.
							22 June	na	No damage.
					25 July—Navy	[9]5	25 July	Carrier plane	One 30-ton boat sunk. Telephone line and smoke duct damaged. Will finish repairs 10 April 1946.
							28 July	na	No damage.
					14 August—20th AF	[9]13	14 August	Directed attack (HE).	Building housing electrolytic cells severely damaged. 28 out of 630 electrolytic cells damaged. Use lost of overhead crane. Estimate repairs completed by 31 Mar. 1946. No estimate given of degree to which some production could be resumed. In March, when first hit, the plant produced 1,443 tons of electrolytic copper. This dropped off to 274 tons in July. Direct damage by raids prior to 14 August was relatively slight, but man-hours lost because of frequent alarms, and other factors effecting the industry in general caused the decline in production.
Mitsubishi Mining Co.	Osaka copper refinery.	14	[8]7	36			1 June	Urban area (IB)	No reported damage.
							7 June	do	Do.
							15 June	do	Control laboratory and repair shops damaged. 72 electrolytic cells and the building housing them were destroyed in the cuprous oxide plant, reducing its capacity 50 percent. Copper vitriol plant also demolished. Company officials estimate electrolytic plant capacity reduced 45 percent and that 1 year would be required to restore it to full capacity.
Ishihara Industrial Co.	Yokkaichi copper smelter.	na	[8]8	na			26 June	Spill-over from raid on Utsube oil refinery (HE).	Severe damage to the smelting furnace caused operations to cease. No estimate of time required for repairs submitted. Damage to smelter reflected in production decline to zero of the Yokkaichi copper refinery.

See footnotes at end of table.

APPENDIX TABLE 2.—*Summary of attacks on Japanese light and non-ferrous metals plants*—Continued

Company	Plant	Position before attack[1]			Dates of AAF making specified target attacks[3]	Tonnage of specified target attacks	Dates hit (1945, except where specified)	Type of attack	Results and notes
		Relative importance							
		Perceotage of total capacity[2]	Perceotage cootribution to total production[2]	Ratio of production to capacity (percent)					
Lead plants									
Japao Mining Co	Saganoseki refinery.	25	30	55		(Refer to "Copper" section above)			The lead refinery was not damaged. (For those parts of the plaot that were damaged, refer to the "Copper" section of this table.)
Mitsubishi Mioing Co	Hosokura ore dressing plant.	Importance can be iofeiied from the figures applyiog to the associated smelter aod refinery.					10 August	Carrier plane	2 bombs hit the crushing plant, elevators, and conveyors; the second tailing thickener along with its platform and rails was damaged by 1 bomb. Electrical equipment was strafed successfully, destroying 3 x 2500 KVA transformers aod cuttiog transmission lines from the substation. A 630 KVA transformer aod some small feeder control panels in the old power bouse were destroyed. The result of the loss of electricity was to stop mining, flood some mine tuooels and motors in a saod pump room. No damage to the smelter or refinery. Lead production was stopped immediately and did oot recommence uotil Sept. 1, 1945. Repair to the dressiog plaot was completed by Sept. 20, 1945.
	Hosokura smelter.	39	59	70			do	do	
	Hosokura refinery.	22	15	30					
Zinc plants									
Mitsubishi Mining Co	Hosokura	13	17	34			10 August	Carrier plane	Power cables were cut, transformers and electrical equipment damaged, electrolytic cells were partially destroyed. Production of zinc was stopped. Production resumed 10 September. (For damage to ore dressing plant refer to the "Lead" section of this table.)
Mitsui Mioing Co	Miike smelter	21	40	84			18 June	Urban area (1B)	Plant or equipmeot oot damaged, some buildings burned. Production retarded but oot stopped.
							27 July	do	Refractory plant, retort plant, ore storehouse, mixing plaot, aod refiniog furnace burned. Much inventory lost, but vital equipment not damaged. Made temporary repairs and tried to resume operations.
							7 August	na	Roof of distillation building burned, refractory plant destroyed. Production stopped and resumed 12 September at 8 percent rate.
Do	Miike refinery	11	10	41			18 June	Urban area (fB)	Storehouse burned. No damage to plant or equipment; production oot affected.
							27 July	do	Acid plant, storehouse, and bathhouse burned. No vital equipmeot knocked out.
							7 August	na	Zinc electrolysis room slightly damaged, minor buildings burned. Forced to stop electrolysis. Resumed production 13 Oct. 1945 at 35 percent.
Tin plants									
Mitsubishi Mining Co	Mitsubishi copper refinery, Osaka.	80 (est.)	78	2			1 June	Urban area (fB)	No damage reported.
							7 June	do	Do.
							15 June		The hydro-fluo-salicylic acid plant was completely destroyed. Production was completely stopped. Repair was well under way by October 1945. 60 days was the estimated additional time required for completing repairs. (For damage to the copper production facilities refer to the "Copper" section of this table.)
Total tonnage directed at other targets which reported no damage					17 May, 20 July, 10 August	10			
Grand total tonnage directed at light aod nonferrous metals plants						269			

oa Indicates data not available.

[1] Base period before attack taken io each case as calendar mooth preceding first date hit, except where otherwise specified.

[2] For alumioa aod aluminum reductioo plants, total pertains to Japao proper, Korea, and Formosa; for magnesium plants, Japan proper, Korea, Maochukuo, and Formosa; for copper, lead, zinc, aod tio plants, Japao proper.

[3] Includes attacks directed specifically at installations by AAF ooly, except for naval attack oo Saganoseki refinery. Data oo other naval attacks against specific targets is not included, because the breakdown by industrial targets is oot available.

[4] Less than 0.5 percent.

[5] Pertains to September 1944.

[6] Pertains to Jaouary 1945.

[7] Pertaios to Juoe 1945.

[8] Pertains to March 1945.

[9] Saganoseki. Total 23.

Source: Production aod capacity percentages were based on data supplied by the Bureau of Mioes, Ministry of Commerce aod Industry, supplemeoted in certain cases from plant questionnaires; data on directed attacks were supplied by the Office of Statistical Control, Headquarters AAF; dates when the plants were hit and the resulting damage were supplied by the Bureau of Mines, Ministry of Commerce aod Industry, supplemeoted from plant questiouoaires November 1945.

APPENDIX TABLE 3.—*Summary of supply of primary aluminum in Japan proper, Korea, and Formosa, fiscal years 1933-45.*

(In metric tons)

Year	Production of Alumina			Production of aluminum ingot	Imports[2]	Total aluminum supply
	From bauxite	From other than bauxite[1]	Total alumina			
1933	----------	100	100	19	3,549	3,568
1934	----------	2,424	2,424	1,002	5,227	6,229
1935	----------	7,434	7,434	3,166	10,949	14,115
1936	----------	13,167	13,167	5,707	10,241	15,948
1937	24,316	7,181	31,497	13,979	13,701	27,680
1938	38,656	9,618	48,274	20,736	23,847	44,583
1939	53,956	11,240	65,196	29,559	36,701	66,260
1940	81,837	15,650	97,487	40,853	na	na
1941	136,837	15,046	151,883	71,740	na	na
1942	212,558	13,623	226,181	103,075	2,000	105,075
1943	304,734	13,757	318,491	141,084	3,000	144,084
1944	190,585	34,626	225,211	110,398	4,205	114,603
1945[3]	1,621	14,598	16,219	6,647	1,070	7,717

na Indicates data not available.

[1] Includes production from aluminous shale, alum-clay, alunite, and scrap.
[2] 1942–45 imports obtained from Manchukuo only.
[3] First quarter only.

Sources: For production data, the Light Metals Control association (KEIKINZOKU TOSEI KAI), with minor adjustments to agree with individual plant data obtained from the Bureau of Mines, Ministry of Commerce and Industry, November 1945. Import data before 1940 were obtained from the Light Metals Control association and, after 1941, were estimated by the Bureau of Mines.

APPENDIX TABLE 4.—*Alumina capacity in Japan proper, Korea, and Formosa, by plant, fiscal years 1935-45* [1]

[In metric tons]

Company	Plant	Basic process [2]	Basic raw material [2]	1935	1936	1937	1938	1939	1940	1941	1942			
											I	II	III	IV
Japan proper														
Asada Chemical Industries Co	Shikama	caustic soda	alunite	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
Dai Nippon Chemical Co	Kawasaki	hydrochloric acid	clay						16,000	19,000	19,000	19,000	18,000	19,000
Japan Aluminum Co	Kurosaki	Bayer	bauxite							79,200	79,200	79,200	79,200	100,000
Japan Light Metals Co	Shimizu	Bayer	bauxite			4,000	13,000	13,000	13,000	16,800	21,600	21,600	24,000	24,000
Japan Soda Co	Takaoka	sulphurous acid	clay											6,000
Kokusan Keigin Co	Iwate	Bayer	bauxite							700	700	700	700	700
Mitsui Light Metals Co	Miike	sulphuric acid	clay											
Nitto Chemical Industries Co	Hachinoe	electric-furnace	aluminous shale	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Showa Denkō Co	Toyama	Bayer	bauxite	10,000	12,000	14,000	24,500	30,000	38,500	45,000	57,000	57,000	57,000	60,000
	Yokohama	Bayer	bauxite		1,500	1,500	4,500	4,500	20,500	24,000	24,000	24,000	45,000	50,000
Sumitomo Chemical Industries Co	Niihama	Bayer	bauxite											
Tōyō Soda Co	Tonda	soda-lime	aluminous shale											
Total				21,400	24,900	30,900	53,400	58,900	99,400	196,100	212,900	212,900	236,300	271,100
Korea														
Chosen Light Metals Co	Chinnampo	electric-furnace	aluminous shale						3,000	3,000	3,000	3,400	3,400	3,400
Japan Nitrogen Fertilizer Co	Kōnan	soda-lime	aluminous shale					6,000	6,000	6,000	6,000	8,000	8,000	8,000
Total								6,000	9,000	9,000	9,000	11,400	11,400	11,400
Formosa														
Japan Aluminum Co	Takao	Bayer	bauxite			12,000	20,000	20,000	24,000	24,000	31,200	31,200	31,200	31,200
Grand total				21,400	24,900	42,900	73,400	84,900	132,400	229,100	253,100	255,500	278,900	313,700

[1] As of end of periods. Quarterly figures are in terms of annual rates.

[2] Designated processes and basic raw materials are largely consistent over the period for non-Bayer, nonbauxitic plants. For Bayer plants, designated processes do not apply to the Yokahoma plant before 1937 and to the Niihama plant before 1938, when both plants were utilizing Korean alunite, and do not apply without qualification to almost all plants during 1944-45, when shortage of bauxite enforced at least partial conversion and a resort to other materials.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 4.—*Alumina capacity in Japan proper, Korea, and Formosa, by plant, fiscal years 1935–45* [1]—Continued

Company	Plant	Basic process [2]	Basic raw material [2]	1943				1944				1945
				I	II	III	IV	I	II	III	IV	I
Japan proper												
Asada Chemical Industries Co.	Shikama	caustic soda	alunite	1,400	1,400	1,400	1,400	1,400	1,400	1,400	14,00	1,400
Dai Nippon Chemical Co.	Kawasaki	hydrochloric acid	clay							400	600	7,200
Japan Aluminum Co.	Kurosaki	Bayer	bauxite	19,000	24,000	24,000	24,000	30,000	31,200	36,000	36,000	36,000
Japan Light Metals Co.	Shimizu	Bayer	bauxite	100,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
Japan Soda Co.	Takaoka	Bayer	bauxite	24,000	24,000	24,000	24,000	24,000	24,000	24,000	12,000	24,000
Kokusan Keigan Co.	Iwate	sulphurous acid	clay						1,200	1,200	1,400	1,400
Mitsui Light Metals Co.	Mike	Bayer	bauxite	12,000	15,000	15,000	24,000	24,000	31,000	36,000	36,000	36,000
Nitto Chemical Industries Co.	Hachinoe	sulphuric acid	clay	700	700	700	700	700	700	700	700	700
Showa Denkō Co.	Toyama	electric-furnace	aluminous shale	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
	Yokohama	Bayer	bauxite	60,000	60,000	60,000	60,000	60,000	68,400	68,400	68,400	68,400
Sumitomo Chemical Industries Co.	Niihama	Bayer	bauxite	50,000	50,000	50,000	54,000	54,000	54,000	54,000	54,000	54,000
Tōyō Soda Co.	Tonda	soda-lime	aluminous shale					6,000	6,000	12,000	12,000	14,000
Total				277,100	305,100	305,100	318,100	330,100	347,900	364,100	352,500	373,100
Korea												
Chosen Light Metals Co.	Chinnampo	electric-furnace	aluminous shale	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400
Japan Nitrogen Fertilizer Co.	Kōnao	soda-lime	aluminous shale	6,000	6,000	6,000	6,000	6,000	6,000	9,600	9,600	9,600
Total				11,400	11,400	11,400	11,400	11,400	11,400	15,000	15,000	15,000
Formosa												
Japan Aluminum Co.	Takao	Bayer	bauxite	31,200	31,200	31,200	31,200	31,200	31,200	31,200	31,200	31,200
Graud total				319,700	347,700	347,700	360,700	372,700	390,500	410,300	398,700	419,300

[1] As of end of periods. Quarterly figures are in terms of annual rates.

[2] Designated processes and basic raw materials are largely consistent over the period for non-Bayer, nonbauxitic plants. For Bayer plants, designated processes do not apply to the Yokahoma plant before 1937 and to the Niihama plant before 1938, when both plants were utilizing Korean alunite, and do not apply without qualification to almost all plants during 1944–45, when shortage of bauxite enforced at least partial conversion and a resort to other materials.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 5.—*Aluminum reduction capacity in Japan proper, Korea, and Formosa, by plant, fiscal years 1935-45* [1]

[In metric tons]

Company	Plant	1935	1936	1937	1938	1939	1940	1941	1942				1943				1944				1945
									I	II	III	IV	I	II	III	IV	I	II	III	IV	I
Japan proper																					
Japan Light Metals Co.	Kambara						4,000	18,000	18,000	18,000	18,000	27,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
	Niigata						1,500	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000
Japan Soda Co.	Takaoka			2,000	6,000	6,000	6,000	9,600	9,600	9,600	9,600	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Kokusan Keigin Co.	Toyama															1,200	1,200	1,200	1,200	1,200	1,200
Showa Denkō Co.	Kitakata															6,000	8,400	8,400	8,400	8,400	8,400
	Ōmachi	4,500	6,500	6,500	10,500	10,500	13,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
	Toyama	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Sumitomo Aluminum Co.	Niihama	3,000	3,000	3,000	3,000	3,000	11,000	11,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	23,400	23,400	23,400	23,400	23,400	23,400
Tohoku Shinkō Aluminum Co.	Koriyama					3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Total		13,000	15,000	17,000	25,000	28,600	44,600	86,700	95,700	95,700	95,700	107,100	116,100	116,100	116,100	126,700	129,100	129,100	129,100	129,100	129,100
Korea																					
Chosen Light Metals Co.	Chinnampo							3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
Japan Nitrogen Fertilizer Co.	Kōnan						4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	6,500	6,500	6,500	6,500	6,500	6,500
Mitsui Light Metals Co.	Yōshi												6,000	12,000	12,000	14,400	20,000	20,000	20,000	20,000	20,000
Total							4,000	7,500	7,500	7,500	7,500	7,500	13,500	19,500	19,500	24,400	30,000	30,000	30,000	30,000	30,000
Formosa																					
Japan Aluminum Co.	Karenkō							4,000	4,000	4,000	4,000	4,800	7,500	7,500	7,500	7,500	9,000	9,000			
	Takao		6,000	9,000	9,000	9,000	9,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	15,000	15,000	15,000		
Total			6,000	9,000	9,000	9,000	9,000	17,000	17,000	17,000	17,000	17,800	20,500	20,500	20,500	20,500	24,000	24,000	15,000		
Grand total		13,000	21,000	26,000	34,000	37,600	57,600	111,200	120,200	120,200	120,200	132,400	150,100	156,100	156,100	171,600	183,100	183,100	174,100	159,100	159,100

[1] As of end of periods. Quarterly figures are in terms of annual rates.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 6.—*Alumina production in Japan proper, Korea, and Formosa, by plant, fiscal years 1935–45*

[In metric tons]

Company	Plant	Basic process[2]	Basic raw material[2]	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945[1]
Japan proper														
Asada Chemical Industries Co.	Shikama	caustic soda	alunite	263	766	864	1,028	1,195	1,103	677	451	633	613	149
Dai Nippon Chemical Co.	Kawasaki	hydrochloric acid	clay										64	2
Japan Aluminum Co.	Kurosaki	Bayer	bauxite						288	14,470	17,391	21,856	11,838	1,061
Japan Light Metals Co.	Shimizu	Bayer	bauxite							17,923	64,085	113,179	71,363	3,554
Japan Soda Co.	Takaoka	Bayer	bauxite			2,391	5,772	9,831	12,597	13,620	19,208	22,826	17,348	1,116
Kokusan Keigin Co.	Iwate	sulphurous acid	clay							228			119	88
Mitsui Light Metals Co.	Muke	Bayer	bauxite									13,956	11,178	413
Nitto Chemical Industries Co.	Hachinoe	sulphuric acid	clay						30	101	176	337	424	19
Showa Denkō Co.	Toyama	electric-furnace	aluminous shale	1,053	2,839	6,214	7,644	9,156	10,573	8,194	6,640	5,764	9,983	2,316
	Yokohama	Bayer	bauxite	6,079	8,693	14,287	18,347	23,263	32,606	44,091	53,376	57,288	43,882	2,256
Sumitomo Chemical Industries Co.	Niihama	Bayer	bauxite	39	869	1,303	3,195	5,143	14,587	20,068	28,412	45,734	28,895	1,662
Tōyō Soda Co.	Tonda	soda-lime	aluminous shale										1,981	1,773
Total				7,434	13,167	25,059	35,986	48,588	71,713	119,372	189,739	281,573	197,628	14,469
Korea														
Chosen Light Metals Co.	Chinnampo	electric-furnace	aluminous shale						200	1,203	3,491	3,852	4,622	793
Japan Nitrogen Fertilizer Co.	Kōnan	soda-lime	aluminous shale					894	3,678	4,699	2,839	3,158	4,991	1,017
Total								894	3,878	5,902	6,330	7,010	9,613	1,810
Formosa														
Japan Aluminum Co.	Takao	Bayer	bauxite			6,438	12,288	15,714	21,896	26,609	30,112	29,908	17,970	
Grand total				7,434	13,167	31,497	48,274	65,196	97,487	151,883	226,181	318,491	225,211	16,219

[1] First quarter only.

[2] Designated processes and basic raw materials are largely consistent over the period for non-Bayer, non-bauxitic plants. For Bayer plants, designated processes do not apply to the Yokohama plant before 1937 and to the Niihama plant before 1938, when both plants were utilizing Korean alunite, and do not apply without qualification to almost all plants during 1944–45, when shortage of bauxite enforced at least partial conversion and a resort to other materials.

Sources: Data for 1935–41, Light Metals Control Association (KEIKINZOKU TOSEI KAI); for 1942–45, Bureau of Mines, Ministry of Commerce and Industry, November 1945

APPENDIX TABLE 7.—*Alumina production in Japan proper, Korea, and Formosa, by plant, monthly, January 1942–June 1945*

[In metric tons]

Company	Plant	Fiscal year 1941				Fiscal year 1942											
		Jan.	Feb.	Mar.	Total 4th qtr.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Japan proper																		
Asada Chemical Industries Co.	Shikama			1	1	64		69	42	31	37	37			16	72	83	451
Nippon Chemical Co.	Kawasaki																	
Japan Aluminum Co.	Kurosaki	1,269	1,058	1,680	4,007	1,615	1,679	1,242	1,154	1,413	1,708	1,449	1,571	1,706	1,395	858	1,610	17,391
Japan Light Metals Co.	Shimizu	3,527	2,929	4,708	11,164	5,236	5,303	5,003	5,033	4,213	4,121	4,391	3,714	6,022	6,251	6,788	8,040	64,085
Japan Soda Co.	Takaoka	843	690	982	2,515	1,146	1,208	1,441	1,385	1,510	1,971	1,449	1,524	2,077	1,930	1,330	2,237	19,208
Kokusan Keigin Co.	Iwate	61			61													
Mitsui Light Metals Co.	Muke																	
Nitto Chemical Industries Co.	Hachinoe			32	32			12		26		39		38		33	176	
Showa Denkō Co.	Toyama	417	119	304	840	582	629	596	640	677	687	714	766	551	492	254	52	6,440
	Yokohama	3,444	3,323	3,657	10,424	3,890	4,688	4,180	4,266	4,374	4,283	4,466	4,586	4,867	4,840	4,402	4,607	53,376
Sumitomo Chemical Industries Co.	Niihama	1,227	1,455	1,701	4,383	1,846	2,077	1,986	1,576	1,931	1,640	2,531	2,029	2,803	2,743	3,087	4,163	28,412
Tōyō Soda Co.	Tonda																	
Total		10,788	9,574	13,065	33,427	14,379	15,584	14,529	14,096	14,072	14,447	15,067	14,190	18,004	17,675	16,791	20,905	189,739
Korea																		
Chosen Light Metals Co.	Chinnampo	152	154	246	552	285	233	257	183	297	315	299	398	533	106	182	403	3,491
Japan Nitrogen Fertilizer Co.	Kōnan	683	318	307	1,308	286	275	444	162	215	229	251	276	231		266	204	2,839
Total		835	472	553	1,860	571	508	701	345	512	544	550	674	764	106	448	607	6,330
Formosa																		
Japan Aluminum Co.	Takao	1,477	2,109	2,311	5,897	1,816	2,601	2,207	2,253	2,382	2,200	2,737	2,578	2,680	3,005	2,761	2,892	30,112
Grand total		13,100	12,155	15,929	41,184	16,766	18,693	17,437	16,694	16,966	17,191	18,354	17,442	21,448	20,786	20,000	24,404	226,181

APPENDIX TABLE 7.—*Alumina production in Japan proper, Korea, and Formosa, by plant, monthly, January 1942–June 1945*—Continued

[In metric tons]

Company	Plant	Fiscal year 1943												
		Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Japan proper														
Asada Chemical Industries Co.	Shikama	3	69	71	47	93	9	76	25	67	74	11	88	633
Nippon Chemical Co.	Kawasaki													
Japan Aluminum Co.	Kurosaki	1,489	1,690	1,651	1,809	1,783	1,701	1,865	1,760	1,921	1,980	1,927	2,280	21,856
Japan Light Metals Co.	Shimizu	8,329	8,928	8,666	9,787	10,030	9,541	9,634	9,371	9,904	10,060	9,164	9,765	113,179
Japan Soda Co.	Takaoka	1,843	1,687	1,842	1,767	1,663	1,546	2,152	1,983	1,998	2,052	2,016	2,277	22,826
Kokusan Keigin Co.	Iwate													
Mitsui Light Metals Co.	Muike	512	767	559	744	816	1,035	1,832	1,503	987	1,343	1,934	1,924	13,956
Nitto Chemical Industries Co.	Hachinoe	50		61			57		66		70		24	337
	Toyama	363	526	540	625	590	542	387	408	572	645	229	337	5,764
Showa Denkō Co.	Yokohama	4,518	4,656	4,823	5,016	4,527	4,591	5,030	4,726	4,938	5,072	4,292	5,099	57,288
Sumitomo Chemical Industries Co.	Niihama	3,648	3,737	4,216	3,458	3,234	3,736	4,424	4,028	3,479	3,599	3,929	4,246	45,734
Toyō Soda Co.	Tonda													
Total		20,764	22,060	22,429	23,253	22,736	22,758	25,400	23,870	23,866	24,895	23,502	26,040	281,573
Korea														
Chosen Light Metals Co.	Chionampo	316	370	386	360	219	195	203	169	431	401	402	400	3,852
Japan Nitrogen Fertilizer Co.	Kōnan		508	201	298	300		486		267	498	107	493	3,158
Total		316	878	587	658	519	195	689	169	698	899	509	893	7,010
Formosa														
Japan Aluminum Co.	Takao	2,556	2,770	2,921	2,545	2,397	2,523	2,522	2,262	2,456	2,168	2,476	2,312	29,908
Grand total		23,636	25,708	25,937	26,456	25,652	25,476	28,611	26,301	27,020	27,962	26,487	29,245	318,491

Company	Plant	Fiscal year 1944													Fiscal year 1945			
		Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total	Apr.	May	June	Total 1st qtr.
Japan proper																		
Asada Chemical Industries Co.	Shikama	89	82	57	70	45	43	92	34	17	54	30		613	74	54	21	149
Nippon Chemical Co.	Kawasaki								8	10	21	23	2	64	2			2
Japan Aluminum Co.	Kurosaki	1,716	1,803	1,634	1,674	1,461	1,386	1,004	237	236	135	192	360	11,838	376	540	145	1,061
Japan Light Metals Co.	Shimizu	9,946	10,175	8,235	8,052	7,205	7,089	6,072	5,045	2,035	2,024	3,080	2,345	71,303	1,724	1,468	362	3,554
Japan Soda Co.	Takaoka	2,117	2,551	2,108	2,058	2,061	1,615	1,686	1,415	644	628	234	231	17,348	103	426	587	1,116
Kokusan Keigin Co.	Iwate					5	15		30	27			12	119	15	40	33	88
Mitsui Light Metals Co.	Mike	1,706	1,862	1,600	1,559	913	1,310	977	703	246	124	32	146	11,178	165	191	57	413
Nitto Chemical Industries Co.	Hachinoe	112	98	8	19		67	36			38		46	424	4		15	19
	Toyama	931	1,015	951	937	863	798	730	720	773	726	729	810	9,983	753	817	746	2,316
Showa Denkō Co.	Yokohama	5,053	5,164	4,505	5,549	4,643	5,041	4,491	3,271	1,554	1,460	1,284	1,867	43,882	805	915	536	2,256
Sumitomo Chemical Industries Co.	Niihama	4,245	4,026	4,196	3,052	3,462	3,548	2,790	882	1,186	587	425	496	28,895	709	520	433	1,662
Tōyō Soda Co.	Tonda	1	20	75	168	188	237	311	291	16	176	304	194	1,981	502	487	784	1,773
Total		25,916	26,796	23,369	23,138	20,846	21,179	18,189	12,636	6,744	5,973	6,333	6,509	197,628	5,232	5,458	3,719	14,409
Korea																		
Chosen Light Metals Co.	Chinnampo	312	243	351	445	489	451	551	402	361	322	341	354	4,622	295	276	222	793
Japan Nitrogen Fertilizer Co.	Kōnan	320	413	531	312	511	382	570	552	426	241	334	399	4,991	404	331	282	1,017
Total		632	656	882	757	1,000	833	1,121	954	787	563	675	753	9,613	699	607	504	1,810
Formosa																		
Japan Aluminum Co.	Takao	2,267	2,319	2,111	2,336	2,032	1,964	1,158	1,409	1,359	733	282		17,970				
Grand total		28,815	29,771	26,362	26,231	23,878	23,976	20,468	14,999	8,890	7,269	7,290	7,262	225,211	5,931	6,065	4,223	16,219

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 8.—*Primary aluminum production in Japan proper, Korea, and Formosa, by plant, fiscal years 1935-45*

[In metric tons]

Company	Plant	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945[1]
Japan proper												
Japan Light Metals Co.	Kambara						2,024	10,216	16,524	34,604	24,793	1,700
	Niigata						217	6,880	14,739	19,284	12,844	209
Japan Soda Col.	Takaoka			953	2,753	4,413	5,090	5,418	9,119	10,390	8,723	340
Kokusan Keigin Co.	Toyama											
Showa Denkō Co.	Kitakata									166	5,061	765
	Omachi	2,952	3,438	5,713	7,364	9,464	10,233	16,276	19,685	21,655	13,740	439
	Toyama	214	1,187	3,471	3,517	3,289	3,713	3,829	5,531	5,834	5,304	987
Sumitomo Aluminum Co.	Nihama		872	1,066	2,494	3,113	6,971	11,453	16,443	18,668	15,421	955
Tohoku Shinkō Aluminum Co.	Koriyama					1,379	2,372	2,001	3,170	3,456	2,368	
Total		3,166	5,497	11,203	16,128	21,658	30,620	56,073	85,211	114,057	88,254	5,404
Korea												
Chosen Light Metals Co.	Chinoampo							582	2,266	3,579	2,838	382
Japao Nitrogen Fertilizer Co.	Kōnan						240	1,481	2,538	3,260	4,096	533
Mitsui Light Metals Co.	Yōshi									5,690	6,009	328
Total						240	1,481	3,120	4,366	12,529	12,943	1,243
Formosa												
Japan Aluminum Co.	Kareukō							329	1,415	3,813	1,638	
	Takao		210	2,776	4,608	7,661	8,762	12,218	12,083	10,685	7,563	
Total			210	2,776	4,608	7,661	8,762	12,547	13,498	14,498	9,201	
Grand total		3,166	5,707	13,979	20,736	29,559	40,863	71,740	103,075	141,084	110,398	6,647

[1] First quarter only.

Sources: Data for 1935–41, Light Metals Control association (KEIKINZOKU TOSEI KAI); for 1942–45, Bureau of Mines, Ministry of Commerce and Industry; November 1945

APPENDIX TABLE 9.—*Primary aluminum production in Japan proper, Korea, and Formosa, by plant, monthly, January 1942–June 1945*

[In metric tons]

Company	Plant	Fiscal year 1941				Fiscal year 1942											
		January	February	March	Total fourth quarter	April	May	June	July	August	September	October	November	December	January	February	March	Total
Japan proper																		
Japan Light Metals Co.	Kambara	1,123	849	1,076	3,048	1,108	1,285	1,269	1,276	1,279	1,251	1,141	1,031	1,213	1,614	1,771	2,286	16,524
	Niigata	694	754	883	2,331	859	1,044	1,204	1,264	1,267	1,242	1,240	1,128	1,164	1,453	1,357	1,517	14,739
Japan Soda Co.	Takaoka	370	405	513	1,288	493	722	569	711	783	816	813	805	891	873	760	883	9,119
Kokusan Keigin Co.	Toyama																	
Showa Denkō Co.	Kitakata																	
	Ōmachi	1,404	1,262	1,382	4,048	1,581	1,694	1,619	1,557	1,588	1,527	1,639	1,579	1,659	1,733	1,640	1,869	19,685
	Toyama	229	171	150	550	211	449	477	491	495	491	496	482	484	492	467	496	5,531
Sumitomo Aluminum Co.	Niihama	985	898	1,013	2,896	1,091	1,273	1,327	1,448	1,445	1,311	1,396	1,359	1,331	1,329	1,486	1,647	16,443
Tohoku Shinkō Aluminum Co.	Koriyama	161	152	185	498	177	328	306	239	326	259	311	211	179	236	334	264	3,170
Total		4,966	4,491	5,202	14,659	5,520	6,795	6,771	6,986	7,183	6,897	7,036	6,595	6,921	7,730	7,815	8,962	85,211
Korea																		
Chosen Light Metals Co.	Chinnampo	72	73	126	271	149	121	118	138	158	170	183	191	185	187	301	365	2,266
Japan Nitrogen Fertilizer Co.	Kōnan	213	202	186	601	195	181	159	119	222	214	196	174	127	140	205	168	2,100
Mitsui Light Metals Co.	Yōshi																	
Total		285	275	312	872	344	302	277	257	380	384	379	365	312	327	506	533	4,366
Formosa																		
Japan Aluminum Co.	Karenkō	51	57	82	190	69	85	102	111	131	126	143	149	122	117	127	133	1,415
	Takao	850	947	1,264	3,061	980	990	970	1,003	1,001	871	982	1,021	1,102	1,061	996	1,106	12,083
Total		901	1,004	1,346	3,251	1,049	1,075	1,072	1,114	1,132	997	1,125	1,170	1,224	1,178	1,123	1,239	13,498
Grand total		6,152	5,770	6,860	18,782	6,913	8,172	8,120	8,357	8,695	8,278	8,540	8,130	8,457	9,235	9,444	10,734	103,075

APPENDIX TABLE 9.—*Primary aluminum production in Japan proper, Korea, and Formosa, by plant, monthly, January 1942–June 1945*—Continued

[In metric tons]

Company	Plant	Fiscal year 1943											
		April	May	June	July	August	September	October	November	December	January	February	March	Total
Japan proper														
Japan Light Metals Co.	Kambara	2,311	2,646	2,624	2,806	2,872	2,962	3,017	2,965	3,184	3,110	2,952	3,155	34,604
	Niigata	1,453	1,530	1,488	1,570	1,571	1,500	1,593	1,623	1,770	1,726	1,641	1,819	19,284
Japan Soda Co.	Takaoka	832	788	847	911	751	760	835	811	850	980	1,000	1,025	10,390
Kokusan Keigin Co.	Toyama													
Showa Denkō Co.	Kitakata												166	166
	Omachi	1,772	1,831	1,740	1,847	1,724	1,640	1,747	1,831	1,990	1,890	1,783	1,860	21,655
	Toyama	495	545	492	468	468	435	444	470	501	500	480	536	5,834
Sumitomo Aluminum Co.	Niihama	1,468	1,630	1,645	1,640	1,461	1,478	1,472	1,471	1,537	1,599	1,506	1,761	18,668
Tohoku Shinkō Aluminum Co.	Koriyama	261	258	222	163	218	287	313	328	341	355	339	371	3,456
Total		8,592	9,228	9,058	9,405	9,065	9,062	9,421	9,499	10,173	10,160	9,701	10,693	114,057
Korea														
Chosen Light Metals Co.	Chinnampo	281	266	284	304	302	276	298	310	324	314	303	317	3,579
Japan Nitrogen Fertilizer Co.	Kōnan	246	220	242	232	234	253	264	246	247	318	328	430	3,260
Mitsui Light Metals Co.	Yōshi		4	119	280	353	469	472	657	895	831	787	823	5,690
Total		527	490	645	816	889	998	1,034	1,213	1,466	1,463	1,418	1,570	12,529
Formosa														
Japan Aluminum Co.	Karenkō	117	260	308	172	304	307	340	364	375	455	390	421	3,813
	Takao	1,051	1,095	1,056	1,083	1,094	1,070	1,040	951	860	590	235	560	10,685
Total		1,168	1,355	1,364	1,255	1,398	1,377	1,380	1,315	1,235	1,045	625	981	14,498
Grand total		10,287	11,073	11,067	11,476	11,352	11,437	11,835	12,027	12,874	12,668	11,744	13,244	141,084

APPENDIX TABLE 9.—*Primary aluminum production in Japan proper, Korea, and Formosa, by plant, monthly, January 1942–June 1945*—Continued

[In metric tons]

Company	Plant	Fiscal year 1944												Fiscal year 1945			
		April	May	June	July	August	September	October	November	December	January	February	March	Total	April	May	June	Total first quarter
Japan proper																		
Japan Light Metals Co.	Kambara	3,203	3,246	3,068	2,515	2,206	2,122	2,181	1,730	1,366	909	944	1,243	24,793	740	725	244	1,709
	Niigata	1,707	1,740	1,618	1,296	1,304	1,203	1,251	780	730	336	365	514	12,844	200			200
Japan Soda Co.	Takaoka	1,034	1,193	988	1,000	992	824	775	766	517	390	173	131	8,723	89	123	137	349
Kokusan Keigin Co.	Toyama																	
Showa Denkō Co.	Kitakata	296	467	500	483	438	501	514	430	487	373	268	304	5,061	285	253	227	765
	Ōmachi	1,865	1,935	1,884	1,595	1,555	1,481	1,177	624	613	431	283	297	13,740	257	88	94	439
	Toyama	535	567	498	506	447	442	415	402	404	380	270	438	5,304	307	376	304	987
Sumitomo Aluminum Co.	Nuhama	2,628	2,117	2,006	1,618	1,378	1,491	1,580	996	973	547	343	344	15,421	471	307	177	955
Tohoku Shinkō Aluminum Co.	Koriyama	409	392	369	331	282	263	185	137					2,368				
Total		11,077	11,657	10,931	9,344	8,662	8,327	8,078	5,805	5,090	3,366	2,646	3,271	88,254	2,349	1,872	1,183	5,404
Korea																		
Chosen Light Metals Co.	Chinnampo	331	330	300	281	293	243	220	216	200	148	116	160	2,838	182	106	94	382
Japan Nitrogen Fertilizer Co.	Kōnan	441	464	455	437	359	343	403	376	293	194	164	167	4,096	182	102	159	533
Mitsui Light Metals Co.	Yōshi	948	1,090	753	503	555	312	477	478	447	224	107	115	6,009	115	111	102	328
Total		1,720	1,884	1,508	1,221	1,207	898	1,100	1,070	940	566	387	442	12,943	479	409	355	1,243
Formosa																		
Japan Aluminum Co.	Karenkō	224	512	485	309	95	6	7						1,638				
	Takao	870	1,027	1,041	1,004	970	863	392	135	672	431	158		7,563				
Total		1,094	1,539	1,526	1,313	1,065	869	399	135	672	431	158		9,201				
Grand total		13,891	15,080	13,965	11,878	10,934	10,094	9,577	7,010	6,702	4,363	3,191	3,713	110,398	2,828	2,281	1,538	6,647

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 10.—*Planned and actual production of aluminum exports to Japan proper, Manchukuo Light Metals Manufacturing company, fiscal years 1938-45.*

[In metric tons]

Year	Planned production	Production	Exports to Japan
1938	2,000	952	.....
1939	5,000	3,257	.....
1940	7,000	5,026	.....
1941	10,000	8,300	800
1942	10,000	7,436	2,000
1943	10,000	8,557	3,000
1944	10,000	7,617	4,205
1945	12,000	[1] 2,000	[1] 1,070

[1] First quarter.

Source: Planned and actual production, Manchukuo Light Metals Manufacturing company (MANSHU KEIKINZOKU SEIZO K.K.); exports to Japan estimated by Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 11.—*Crude metal production from direct electrolysis of shale in Japan proper and Korea, quarterly, fiscal years 1944-45.*

[In metric tons]

Period	Japan	Korea	Total
1944—			
I	.....	.....	.....
II	.....	.....	.....
III	560	.....	560
IV	1,294	173	1,467
Total	1,854	173	2,027
1945—			
I	3,566	159	3,725

Source: Light Metals Control association (KEIKINZOKU TOSEI KAI), November 1945.

APPENDIX TABLE 12.—*Aluminous clinker production in cement plants, Japan proper, monthly, February 1943-August 1945*

[In metric tons]

Period	Onoda Cement Co.		Asano Cement Co. Itozaki plant	Total
	Onoda plant	Yawata plant		
1943				
February	624	.....	.....	624
March	3,826	.....	.....	3,826
Total	4,450	.....	.....	4,450
1944				
April	3,978	.....	.....	3,978
May	4,082	.....	805	4,887
June	2,629	.....	1,729	4,358
July	5,545	.....	950	6,495
August	6,193	.....	2,855	9,048
September	3,501	.....	1,650	5,151
October	6,048	.....	1,500	7,548
November	3,403	.....	2,000	5,403
December	3,459	.....	3,020	6,479
January	5,910	1,918	3,100	10,928
February	4,850	2,344	3,360	10,554
March	3,826	2,173	2,420	8,419
Total	52,524	6,435	23,389	82,348
1945				
April	3,353	1,818	550	5,721
May	3,511	2,216	.....	5,727
June	5,019	2,006	.....	7,025
July	2,029	1,841	.....	3,870
August	207	897	.....	1,104
Total	14,119	8,778	550	23,447

Source: Light Metals Control association (KEIKINZOKU TOSEI KAI), November 1945.

APPENDIX TABLE 13.—*Imports of bauxite to Japan proper and Formosa, by region of origin, fiscal years 1935-45* [1]

[In metric tons]

Year	Palao	Bintan	Malaya (Johore and Malacca)	Indo-China	Others	Total
1935	.....	.....	.....	.....	.....	.....
1936	.....	9,192	958	.....	14,612	24,762
1937	.....	46,663	27,984	.....	26,502	101,149
1938	3,655	117,269	76,505	.....	23,049	220,478
1939	13,987	202,081	101,692	.....	31,698	352,458
1940	22,495	194,729	62,965	.....	.....	280,189
1941	39,297	58,059	26,140	3,215	.....	146,711
1942	103,907	274,449	55,831	15,947	.....	450,134
1943	84,940	594,589	138,555	2,450	.....	820,534
1944	4,488	287,782	55,065	.....	.....	347,335
1945	.....	1,800	.....	.....	.....	1,800

[1] By net weight 1935–41; by dry weight 1942–45. Moisture content approximately 10 per cent.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 14.—*Imports of bauxite to Japan proper and Formosa, by region of origin, monthly, fiscal years 1942-45* [1]

[In metric tons]

Year	Palao	Bintan	Malaya (Jahore and Malacca)	Indo-China [2]	Total
1942					
April	10,052	.....	.....	1,329	11,381
May	8,857	8,085	.....	1,329	18,271
June	6,222	3,218	.....	1,329	10,769
July	1,310	18,983	3,386	1,329	25,008
August	5,229	19,812	4,405	1,329	30,775
Septeoiber	8,598	34,891	2,832	1,329	47,650
October	9,246	13,023	11,603	1,329	35,201
November	10,458	24,272	.....	1,329	36,059
December	14,807	40,879	9,339	1,329	66,354
January	7,527	30,760	10,729	1,329	50,345
February	6,118	26,394	6,793	1,329	40,634
March	15,483	54,132	6,244	1,328	77,187
Total	103,907	274,449	55,831	15,947	450,134
1943					
April	.....	82,702	30,433	205	113,340
May	12,129	33,183	11,047	204	56,563
June	8,076	41,742	12,119	204	62,141
July	9,992	32,108	10,918	205	53,223
August	2,897	56,991	6,792	204	66,884
September	8,676	49,666	9,321	204	67,867
October	.....	40,585	13,963	204	54,752
November	3,574	40,363	6,378	204	50,519
December	14,021	82,223	18,744	204	115,192
January	8,886	65,743	6,860	204	81,693
February	.....	50,368	4,673	204	55,245
March	16,689	18,915	7,307	204	43,115
Total	84,940	594,589	138,555	2,450	820,534
1944					
April	1,000	36,630	.....	.....	37,630
May	.....	13,028	13,860	.....	26,888
June	.....	61,532	15,420	.....	76,952
July	.....	24,350	.....	.....	24,350
August	3,488	79,630	10,330	.....	93,448
September	.....	8,525	9,455	.....	17,980
October	.....	9,695	.....	.....	9,695
November	.....	13,860	.....	.....	13,860
December	.....	6,400	.....	.....	6,400
January	.....	21,590	6,000	.....	27,590
February	.....	11,927	.....	.....	11,927
March	.....	615	.....	.....	615
Total	4,488	287,782	55,065	.....	347,335
1945					
April	.....	1,800	.....	.....	1,800
May	.....	.....	.....	.....	.....
June	.....	.....	.....	.....	.....

[1] Quantities in terms of dry weight.
[2] Monthly quantities derived by pro-rating annual totals.

Source: Bureau of Mines, Department of Commerce and Industry, November 1945.

APPENDIX TABLE 15.—*Imports of North China aluminous shale, Japan proper and Korea, fiscal years 1935-45*

[In metric tons]

Year	Japan proper	Korea	Total
1935	3,690		3,690
1936	8,360		8,360
1937	21,750		21,750
1938	26,750		26,750
1939	32,040	3,950	35,990
1940	37,000	14,710	51,710
1941	25,465	19 500	44,965
1942			
April	1,500		1,500
May		285	285
June	2,157	3,790	5,947
July	3,030	2,474	5,504
August	1,554	3,757	5,311
September	2,202	5,550	7,752
October		5,027	5,027
November	2,949		2,949
December	3,603		3,603
January		2,591	2,591
February	3,128		3,128
March	3,761		3,761
Total	23,884	23,474	47,358
1943			
April	2,755	2,657	5,412
May		3,214	3,214
June	3,722	1,857	5,579
July			
August	1,497	6,245	7,742
September		1,478	1,478
October	1,871	2,183	4,054
November	1,870	3,250	5,120
December	5,029	1,568	6,597
January			
February	2,174	2,236	4,410
March	6,893		6,893
Total	25,811	24,688	50,499
1944			
April	10,612	6,349	16,961
May	20,064	1,470	21,534
June	6,902	3,481	10,383
July	12,517	1,774	14,291
August	4,320	1,642	5,962
September	1,563	5,247	6,810
October	12,052	6,320	18,372
November	1,773	3,872	5,645
December	4,205		4,205
January	20,201	710	20,911
February	11,801		11,801
March	8,939	1,597	10,536
Total	114,949	32,462	147,411
1945			
April	8,934		8,934
May	25,768	1,188	26,956
June	1,724		1,724
July			
August			
Total	36,426	1,188	37,614

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 16.—*Stocks of bauxite, aluminous shale, alumina, and primary aluminum ingot in Japan proper, Formosa and Korea, 1941-45.*

[In metric tons]

Date [1]	Bauxite [2]	Aluminous shale [3]	Alumina	Primary ingot [4]
1941				
December	254,740	3,650	5,500	
1942				
March	191,174	6,520	4,190	7,000
June	172,620	1,522	7,293	8,100
September	183,247	8,766	2,051	10,900
December	209,427	9,572	3,002	12,500
1943				
March	209,607	11,855	2,897	10,400
June	206,287	13,844	3,005	8,000
September	201,648	13,635	22,256	5,500
December	296,981	19,474	19,331	4,800
1944				
March	238,471	20,692	19,525	3,700
June	176,241	36,109	10,491	9,700
September	36,196	37,664	11,576	6,900
December	2,651	32,061	4,227	4,700
1945				
March	5,233	38,767	1,543	5,300
June		55,168	998	5,700
August		33,705	4,659	4,129

[1] End of month.
[2] Held in Japan proper and Formosa.
[3] Held in Japan proper and Korea.
[4] Includes stocks at all reduction plants and in the hands of the Imperial Light Metals Control company (TEIKOKU KEIKINZOKU TOSEI KABUSHIKI KAISHA), but excludes stocks held at fabricating plants.

Source: Light Metals Control association (KEIKINZOKU TOSEI KAI), November 1945.

APPENDIX TABLE 17.—*Analysis of aluminous shale received and aluminous clinker produced, Onoda Cement company, Onoda plant, April 1944–August 1945.*

[Average analysis of aluminous shale received]

Period	Loss on ignition	SiO_2	Al_2O_3	Fe_2O_3	CaO	Total
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
April–September 1944	14.33	19.66	50.48	12.48	1.93	98.88
October 1944–March 1945	14.15	19.56	53.42	10.37	0.76	98.26
April–August 1945	14.17	17.26	57.12	12.42	0.80	101.77

[Average analysis of aluminous clinker produced]

Period	Loss on ignition	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	Total
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
April–September 1944	1.07	15.55	35.00	7.85	19.35	20.25	99.07
October 1944–March 1945	1.28	15.32	33.17	7.29	20.48	21.54	99.08
April–August 1945	1.97	16.10	32.64	7.55	17.77	22.30	98.33

Source: Onoda Cement company, Onoda plant, November 1945.

APPENDIX TABLE 18.—*Mobilization plan for allocation of primary aluminum, quarterly, fiscal years 1942-45* [1]

[In metric tons]

Period	Aircraft [2]	Army [3]	Navy [3]	Indirect military and civilian	Total
1942					
I		11,489	10,865	5,836	28,190
II		12,695	12,005	6,450	31,150
III		11,474	10,599	5,554	27,327
IV		12,023	11,569	6,111	29,703
Total		47,381	45,038	23,951	116,370
1943					
I		14,384	13,838	5,263	33,485
II		15,586	15,428	5,379	36,393
III		16,969	16,796	5,860	39,625
IV		18,218	18,033	6,296	42,547
Total		65,157	64,095	22,798	152,050
1944					
I	36,600	4,630		3,010	44,240
II	34,419	1,037	1,156	1,638	38,250
III	26,320	680	750	1,275	29,025
IV	20,700	1,225			21,925
Total	118,039	9,478		5,923	133,440
1945					
I	15,200	(	800	)	16,000

[1] The planned totals include expected production in Japan proper, Korea, and Formosa plus imports from Manchukuo. Planned exports to Manchukuo and Occupied China are included in "Indirect military and civilian." For 1942 and 1943 plans were made as of the beginning of each fiscal year. For 1944 and 1945 plans were made quarterly.

[2] Corresponds to the "D" category of the national allocations program.

[3] Quantities for 1942 and 1943 include planned allocations for aircraft, which were grouped under a separate category in 1944.

Source: Light Metals Control association (KEIKINZOKU TOSEI KAI), November 1945.

APPENDIX TABLE 19. *Allotment of primary aluminum to allocation categories, quarterly, fiscal years 1942-45* [1]

[In metric tons]

Period	Aircraft [2]	Army	Navy	Indirect military and civilian	Total
1942					
I	17,184	4,221	1,216	5,569	28,190
II	14,501	3,638	1,233	5,062	24,524
III	16,100	3,750	1,923	5,554	27,327
IV	18,339	3,245	1,520	5,581	28,685
Total	66,214	14,854	5,892	21,766	108,726
1943					
I	23,961	2,877	1,384	5,263	33,485
II	25,854	3,117	1,543	5,379	35,893
III	27,185	2,819	1,571	5,348	36,923
IV	28,290	2,515	2,555	5,777	39,137
Total	105,290	11,328	7,053	21,767	145,438
1944					
I	33,097	2,175	2,134	2,600	40,006
II	34,419	1,037	1,156	1,638	38,250
III	16,352	423	465	792	18,032
IV	16,223				16,223
Total	100,091	3,635	3,755	5,030	112,511
1945					
I	10,200				10,200

[1] Quantities are those alloted under the distribution program of the Imperial Light Metals Control company (TEIKOKU KEIKINZOKU TOSEI KABUSHIKI KAISHA). Totals approximate total production in Japan proper, Korea and Formosa plus receipts from Manchukuo.

[2] Quantities for 1942 and 1943 constitute estimated portion destined for aircraft of total aluminum allocated to Army and Navy categories.

Source: Light Metals Control association (KEIKINZOKU TOSEI KAI), November 1945.

APPENDIX TABLE 20.—*Production and distribution of secondary aluminum in Japan proper, fiscal years 1942-45* [1]

[In metric tons]

Year	Total production	Distribution		
		Aircraft	Army and Navy	Civilian and indirect military
1942	9,339	2,335	2,335	4,669
1943	11,220	2,805	2,805	5,610
1944	10,448	7,314	.....	3,134
1945 [2]	1,289	1,224	.....	65

[1] Includes remelted ingot produced by the Kantō and Kansai remelting companies (KANTŌ and KANSAI KEIKINZOKU SAISEI KOGYO KABUSHIKI KAISHA) and channelled through the Imperial Light Metals Control company (TEIKOKU KEIKINZOKU TOSEI KABUSHIKI KAISHA), but excludes aircraft processing wastage—i.e. "new scrap."
[2] April–August

Source: Estimated by Light Metals Control association (KEIKINZOKU TOSEI KAI), November 1945.

APPENDIX TABLE 21.—*Percentage composition of aluminum ingot produced in representative Japanese plants, 1936-45*

Period	Sumitomo Chemical Industries Co. Niihama plant			Japan Light Metal Co. Niigata plant [2]			Japan Light Metal Co. Niigata plant [3]			Showa Denko Co. Toyama plant [3]		
	Fe	Si	Al [1]	Fe	Si	Al [1]	Fe	Si	Al [1]	Fe	Si	Al [1]
1936	0.21	0.30	99.49	.....	.....	.....	.....	.....	.....	.....	.....	.....
1937	.11	.17	99.72	.....	.....	.....	.....	.....	.....	.....	.....	.....
1938	.18	.19	99.63	.....	.....	.....	.....	.....	.....	.....	.....	.....
1939	.17	.20	99.63	.....	.....	.....	.....	.....	.....	.....	.....	.....
1940	.16	.23	99.61	.....	.....	.....	.....	.....	.....	.....	.....	.....
1941 December	.17	.23	99.60	0.37	0.18	99.45	.....	.....	.....	.....	.....	.....
1942 December	.19	.28	99.53	.39	.32	99.29	.....	.....	.....	.....	.....	.....
1943 December	.21	.27	99.52	.25	.21	99.54	.....	.....	.....	.....	.....	.....
1944 July	.23	.28	99.49	.37	.44	99.19	.....	.....	.....	.....	.....	.....
August	.21	.27	99.52	.36	.38	99.26	.....	.....	.....	.....	.....	.....
September	.20	.23	99.57	.36	.27	99.37	.....	.....	.....	.....	.....	.....
October	.20	.32	99.48	.36	.29	99.35	.....	.....	.....	.....	.....	.....
November	.33	.49	99.18	.32	.43	99.25	1.42	3.06	95.52	.39	1.04	98.57
December	.53	.56	98.91	.38	.53	99.09	.63	1.15	98.22	.38	.88	98.74
1945 January	1.05	.96	97.99	.57	.78	98.65	1.21	2.00	96.79	.79	.86	98.35
February	.98	.95	98.07	.49	.55	98.96	1.16	1.89	96.95	1.36	1.30	97.34
March	.77	.83	98.40	.38	.38	99.24	.99	2.07	96.94	.....	.....	.....
April	.60	.81	98.59	.29	.33	99.38	1.29	2.47	96.24	.....	.....	.....
May	.55	.70	98.75	.....	.....	.....	2.37	3.12	94.51	.....	.....	.....
June	.72	.87	98.41	.....	.....	.....	2.48	3.14	94.38	.....	.....	.....
July	.44	.76	98.80	1.47	2.38	96.15	2.43	3.45	94.12	.....	.....	.....
August	.67	.94	98.39	.72	1.67	97.61	2.40	3.53	94.07	.....	.....	.....

[1] Aluminum by difference.
[2] Niigata plant used two raw materials: alumina, beginning in 1941; and dross, beginning in November 1944.
[3] Toyama plant also electrolyzed shale directly, producing an ingot containing about 7 percent iron, 11 percent silicon, 1 percent titanium, and 81 percent aluminum.

Source: Plant data from indicated companies, November 1945.

APPENDIX TABLE 22.—*Specifications for representative Japanese aluminum alloy castings*

Specification number [1]	Abbreviation	Condition	Percentage content							Min. T. S. (Kg/mm²)	Min. Elong. (percent)	Brinell	H. T.	Age
			Cu	Mg	Mn	Si	Fe	Sn	Impurities					
Sand cast														
7230	Chi 501 A	As cast	4.0 to 5.0			1.2 max.	1.0 max.			15	3			
7230	Chi 501 B	H. T. and aged	4.0 to 5.0			1.2 max.	1.0 max.			26	3	80	510° C. WQ	150° C. 10 hrs.
7230	Chi 502 A	As cast	3.5 to 4.5	0.2 max.		4.0 to 5.0	.8 max.			16	2			
7230	Chi 504 A	As cast		.3 to .8	0.3 to .08	8.0 to 10.0	.8 max.			18	3			170° C.
7230	Chi 504 B	H. T. and aged		.3 to .8	.3 to .8	8.0 to 10.0	.8 max.			25	2	95	520° C. OQ	
7230	Chi 507 B	H. T. and aged.	3.5 to 4.5	1.0 to 2.0	.2 to .5	1.0 max.	.8 max.			25		90	490°–510° C. AC	200° C.
7232	Chi 701		2.0 to 3.0					7.0 to 9.0				40	200° C. AC	170° C.
7233 [3]	Chi 512 A	As cast	2.0 to 4.5	1.5 max.		3.0 to 6.0	1.5 max.			14				
7233 [3]	Chi 512 B	H. T. and aged	2.0 to 4.5	1.5 max.		3.0 to 6.0	1.5 max.			24		90	500° C. WQ	
7233 [3]	Chi 514 A	As cast	4.0 max.	1.5 max.	.8 max.	6.0 to 10.0	1.0 max.			13				
Die cast														
7231	Chi 602		3.5 to 4.5			4.0 to 5.0	1.5 max.		1.0 max.	16	2			
7231	Chi 605			4.0 to 7.0	.1 to .5		1.5 max.		1.0 max.	18	5			
7234 [3]	Chi 612		2.0 to 4.5	1.5 max.		3.0 to 6.0	2.0 max.			14				

[1] Parts of included specifications referring to other alloys and tempers have been omitted.
[2] WQ—water quench; OQ—oil quench; AC—air cool.
[3] 7233 and 7234 were called "Wartime aluminum" castings.

Source: "Japanese Aeronautical Specifications," Technical Institute (GIJUTSUIN), Non-ferrous Metals, November 1944.

APPENDIX TABLE 23.—*Specifications for representative Japanese wrought aluminum alloys*

Specification number	Abbreviation	Industrial code	Percentage content								Mechanical properties [2]				H. T. [3]	Age
			Cu	Zn	Mg	Mn	Cr	Si	Fe	Al	Y. S. (Kg/mm²)	T. S. (Kg/mm²)	Elong. (percent)	Brinell		
7214	Chi 202		3.8 to 4.8		1.2 to 1.8	0.4 to 1.0		0.5 max.	0.6 max.	Rem.	27 to 24	44 to 38	12		490°–500° C. WQ	
7216	Chi 214		4.0 to 5.0			.5 to 1.2		.5 to 1.2	.8 max.	Rem.	22	38	14	95	510°–530° C. WQ	120°–160° C. 12–24 hrs.
7218	Chi 221		3.3 to 4.2		.3 to .7	.3 to .7		.5 max.	.6 max.	Rem.	22 to 21	38 to 36	12 to 15		490°–520° C. WQ	Room Temp.
7218	Chi 222 B	SDH	3.8 to 4.8		1.2 to 1.8	.4 to 1.0		.5 max.	.6 max.	Rem.	27 to 28	42 to 44	12 to 15		490°–500° C. WQ	Room Temp.
7218	Chi 223 C	ESDT	.8 to 1.7	7.0 to 9.0	1.2 to 1.8	.3 to 1.0	0.1 to 0.4	.6 max.	.6 max.	Rem.	45 to 42	53 to 50	8 to 5		420°–460° C. WQ	110°–130° C. 24 hrs.
7219 [1]	Chi 232 B	SDCH	skin		.4 to 1.0	1.0 to 2.0		.5 max.	.6 max.	Rem.	27	42 to 43	15 to 12		490°–500° C. WQ	Room Temp.
			core		1.2 to 1.8	.4 to 1.0		.5 max.	.6 max.	Rem.						
7219 [1]	Chi 233 C	ESDCT	skin					.2 max.	.5 to 3.0	Rem.	42	49	8		420°–460° C. WQ	110°–130° C. 24 hrs.
			core				.1 to .4	.5 max.	.5 max.	Rem.						
7222 [1]	Chi 267 C	HDT	.8 to 1.7	7.0 to 9.0	1.2 to 1.8	.3 to 1.0	.1 to .4	.6 max.	.6 max.	Rem.	45 to 48	50 to 53	6 to 5		420°–460° C. WQ	110°–130° C. 24 hrs.
			.8 max.	5.0 to 5.8	1.5 to 2.5	.3 to .8	.1 to .4	.5 max.	.6 max.	Rem.					400°–440° C. WQ	110°–130° C. 24 hrs.

[1] Parts of specifications referring to other tempers have been omitted.
[2] Mechanical properties are probably minima. Where more than one value is shown, they are for different thicknesses given in the original specification.
[3] WQ—water quench.

Source: "Japanese Aeronautical Specifications," Technical Institute (GIJUTSUIN), Non-ferrous Metals, November 1944.

APPENDIX TABLE 24.—*Summary of Japan's magnesium capacity and supply, fiscal years 1935-45*

[In metric tons]

Year	Capacity			Production			Supply			
	Japan proper	Korea Manchukuo Formosa	Total	Japan proper	Korea Manchukuo Formosa	Total	Secondary ingot	Imports	Exports	Total magnesium supply [1]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1935	1,500	.....	1,500	379	.....	379	.....	.....	.....	379
1936	1,500	.....	1,500	637	.....	637	.....	.....	.....	637
1937	1,600	.....	1,600	892	.....	892	.....	.....	11	881
1938	1,900	50	1,950	1,114	42	1,156	.....	1,650	1	2,805
1939	2,750	100	2,850	1,825	111	1,936	.....	798	1	2,733
1940	3,250	400	3,650	2,526	280	2,806	.....	.....	1,019	1,787
1941	3,365	835	4,200	2,193	366	2,559	.....	.....	115	2,444
1942	3,627	1,205	4,832	2,121	557	2,678	66	.....	1	2,743
1943	4,015	3,755	7,770	2,845	1,000	3,845	196	.....	2	4,039
1944	4,705	5,735	10,440	2,577	2,548	5,125	183	.....	.....	5,308
1945 [2]	4,800	5,860	10,660	404	587	991	62	.....	.....	1,053

[1] Stocks not included.
[2] First quarter only.

Source: Bureau of Mines, Ministry of Commerce and Industry; Light Metal Control association (KEIKINZOKU TOSEI KAI); Bureau of Taxation, Ministry of Finance November 1945.

APPENDIX TABLE 25.—*Magnesium capacity, Japan proper, Korea and Formosa, fiscal years 1935-45*

[In metric tons]

Company	Plant	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Japan proper												
Asahi Electric Industrial Company	Ogu	.....	.....	100	400	400	400	400	300	345	300	360
Japan Magnesium Company	Toyama	.....	.....	.....	.....	.....	.....	50	67	210	360	360
Kaoto Electric Industrial Company	Shibukawa	.....	.....	.....	.....	500	1,000	1,000	1,080	1,080	1,440	1,440
Riken Metal Manufacturing Company	Ube	1,500	1,500	1,500	1,500	1,500	1,500	1,515	1,560	1,560	1,560	1,560
Shinetsu Chemical Industrial Company	Naoetsu	.....	.....	.....	.....	300	300	300	310	420	475	480
Teikoku Magnesium Company	Sakata	.....	.....	.....	.....	50	50	100	310	400	600	600
Total		1,500	1,500	1,600	1,900	2,750	3,250	3,365	3,627	4,015	4,705	4,800
Korea												
Asahi Light Metal Manufacturing Company	Kiyo	.....	.....	.....	.....	.....	.....	.....	.....	.....	50	600
Korea Light Metal Manufacturing Company	Chiuoampo	.....	.....	.....	.....	.....	.....	.....	.....	150	600	600
Chosen Shinko Metal Manufacturing Company	Shiogishu	.....	.....	.....	.....	.....	.....	.....	65	445	920	960
Mitsubishi Magnesium Company	Chinampo	.....	.....	.....	.....	.....	.....	.....	.....	825	1,065	1,200
Mitsui Yushi Chemical Industrial Company	Sanchoku	.....	.....	.....	.....	.....	.....	.....	.....	.....	360	480
Nichitsu Magnesium Company	Konan	.....	.....	.....	50	100	400	445	600	705	1,020	1,020
Total		.....	.....	.....	50	100	400	445	665	2,125	4,015	4,860
Manchukuo												
Manshu Magnesium Company	Eiko	.....	.....	.....	.....	.....	.....	.....	.....	1,000	1,000	1,000
Formosa												
Asahi Electric Industrial Company	Takao	.....	.....	.....	.....	.....	.....	390	540	630	720	.....
Grand Total		1,500	1,500	1,600	1,950	2,850	3,650	4,200	4,832	7,770	10,440	10,660

Source: Bureau of Mines, Ministry of Commerce and Industry, and Manshu Magnesium Co., November 1945.

APPENDIX TABLE 26. *Magnesium production in Japan proper and Japanese-controlled areas, by process used, fiscal years 1939-45*

[In metric tons]

Company	Plant	1939	1940	1941	1942	1943	1944	1945 First quarter
Asahi Process [1]								
Asahi Electric Industrial Company	Ogu	421	336	239	225	236	233	2
Kanto Electric Industrial Company	Shibukawa	258	820	826	892	962	702	134
Teikoku Magnesium Company	Sakata	8	26	50	94	183	367	41
Asahi Light Metal Manufacturing Company, Ltd.	Kiyo						5	22
Mitsui Yushi Chemical Industrial Company	Sanchoku						52	15
Manshu Magnesium Company	Eiko					na	402	92
Asahi Electric Industrial Company	Takao			142	297	381	310	
Total		687	1,182	1,257	1,508	(1,762)	2,071	303
Brine Process [2]								
Japan Magnesium Company	Toyama			23	23	115	254	63
Riken Metal Manufacturing Company	Ube	889	1,125	808	674	1,030	693	83
Shinetsu Chemical Industrial Company	Naoetsu	249	219	247	213	319	328	84
Korea Light Metal Manufacturing Company	Chinnampo					9	161	19
Korea Shinko Metal Manufacturing Company	Shingishu				20	200	446	128
Mitsubishi Magnesium Company	Chinnampo					222	695	203
Total		1,138	1,344	1,078	930	1,895	2,577	580
Hansgirg Process [3]								
Nichitsu Magnesium Company, Limited	Konan	111	280	224	240	271	477	108
Grand total		1,936	2,806	2,559	2,678	(3,928)	5,125	991

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Asahi process: reduction and chlorination of magnesia and electrolysis of anhydrous Mg Cl- thus produced.
[2] Brine process: purification and dehydration of natural brine followed by electrolysis of mixed fused chlorides.
[3] Hansgirg process: high temperature reduction of magnesite with condensation of Mg powder in cooling gas and subsequent recrystallization.

Source: Bureau of Mines, Ministry of Commerce and Industry; Teikoku Magnesium company; and Riken Metal Manufacturing company, November 1965.

APPENDIX TABLE 27.—*Magnesium production, Japan proper, Korea, Manchukuo, and Formosa, fiscal years 1935-45*

[In metric tons]

Company	Plant	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 [1]
Japan proper												
Asahi Electric Industrial Company	Ogu			62	264	421	336	239	225	236	233	2
Japan Magnesium Company	Toyama							23	23	115	254	63
Kanto Electric Industrial Company	Shibukawa					258	820	826	892	962	702	134
Riken Metal Manufacturing Company	Ube	379	637	830	850	889	1,125	808	674	1,030	693	83
Shinetsu Chemical Industrial Company	Naoetsu					249	219	247	213	319	328	84
Teikoku Magnesium Company	Sakata					8	26	50	94	183	367	41
Total		379	637	892	1,114	1,825	2,526	2,193	2,121	2,845	2,577	404
Korea												
Asahi Light Metal Manufacturing Company	Kiyo										5	22
Korea Light Metal Manufacturing Company	Chinnampo									9	161	19
Korea Shinko Metal Manufacturing Company	Shingishu								20	200	446	128
Mitsubishi Magnesium Company	Chinnampo									222	695	203
Mitsui Yushi Chemical Industrial Company	Sanchoku										52	15
Nichitsu Magnesium Company	Konan				42	111	280	224	240	271	477	108
Total					42	111	280	224	260	702	1,836	495
Manchukuo												
Manshu Magnesium Company	Eiko									na	402	92
Formosa												
Asahi Electrical Industrial Company	Takao							142	297	381	310	
Grand total		379	637	892	1,156	1,936	2,806	2,559	2,678	(3,928)	5,125	991

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] First quarter only.

Source: Bureau of Mines, Ministry of Commerce and Industry; Light Metals Control association (KEIKINZOKU TOSEI KAI); Teikoku Magnesium company; and Riken Manufacturing company, November 1945.

APPENDIX TABLE 28.—*Magnesium production, Japan proper, Korea, Manchukuo and Formosa, monthly, fiscal years 1942-45*

[In metric tons]

1942

Company	Plant	April	May	June	July	August	September	October	November	December	January	February	March	Total
Japan proper														
Asahi Electric Industrial Company	Ogu	17	17	18	17	15	15	23	23	22	21	17	29	225
Japan Magnesium Company	Toyama									5		13	5	23
Kanto Electric Industrial Company	Shibukawa	88	84	71	54	57	55	69	72	80	86	82	94	892
Riken Metal Manufacturing Company	Ube	33	48	75	78	67	16	37	70	73	65	52	60	674
Shinetsu Chemical Industrial Company	Naoetsu	20	20	20	17	11	10	18	18	17	18	19	25	213
Teikoku Magnesium Company	Sakata	9	5	2	4	5	8	11	9	12	8	10	11	94
Total		167	174	186	170	155	104	158	192	209	198	193	245	2,121
Korea														
Korea Shinko Metal Manufacturing Co.	Shingishu								1	8	1	10		20
Nichitsu Magnesium Company	Konan	14	13	13	16	36	17	12	25	19	25	23	27	240
Total		14	13	13	16	36	17	12	26	27	26	33	27	260
Manchukuo														
Manshu Magnesium Company	Eiko										na	na	na	na
Formosa														
Asahi Electric Industrial Company	Takao	15	22	21	20	17	20	26	17	26	36	37	40	297
Grand total		196	209	220	206	208	141	196	235	262	260	263	282	2,678

1943

Company	Plant	April	May	June	July	August	September	October	November	December	January	February	March	Total
Japan proper														
Asahi Electric Industrial Company	Ogu	18	15	18	15	11	15	18	22	25	26	26	27	236
Japan Magnesium Company	Toyama	4	7	6	7	7	7	10	13	13	13	14	14	115
Kanto Electric Industrial Company	Shibukawa	93	83	85	83	80	76	36	79	91	90	78	88	962
Riken Metal Manufacturing Company	Ube	85	63	78	63	87	81	76	84	94	100	103	116	1,030
Shinetsu Chemical Industrial Company	Naoetsu	27	27	27	27	20	15	36	32	30	26	32	20	319
Teikoku Magnesium Company	Sakata	7	5	9	5	9	15	18	19	18	18	25	35	183
Total		234	200	223	200	214	209	194	249	271	273	278	300	2,845
Korea														
Korea Light Metal Manufacturing Co.	Chinnampo										4	2	3	9
Korea Shinko Metal Manufacturing Co.	Shingishu	3	7	7	5	3	16	25	30	31	17	19	37	200
Mitsuhishi Magnesium Company	Chinnampo	20	3	15	16	12	11	14	18	32	32	40	9	222
Nichitsu Magnesium Company	Konan	28	24	15	24	18	21	16	3	15	46	24	43	271
Total		51	34	37	45	33	48	55	51	78	93	85	92	702
Manchukuo														
Manshu Magnesium Company	Eiko	na	na	na	na	na	na	na	na	na	na	na	na	na
Formosa														
Asahi Electric Industrial Company	Takao	36	21	20	21	20	16	32	37	41	51	46	40	381
Grand total		(321)	(255)	(280)	(266)	(267)	(273)	(281)	(337)	(390)	(417)	(409)	(432)	(3,928)

1944

Company	Plant	April	May	June	July	August	September	October	November	December	January	February	March	Total
Japan proper														
Asahi Electric Industrial Company	Ogu	28	29	24	7	13	6	14	25	27	29	22	9	233
Japan Magnesium Company	Toyama	15	16	16	17	18	19	21	23	25	29	25	30	254
Kanto Electric Industrial Company	Shibukawa	76	80	75	66	45	28	50	62	50	66	49	55	702
Riken Metal Manufacturing Company	Ube	94	78	68	51	50	39	57	46	61	60	40	40	693
Shinetsu Chemical Industrial Company	Naoetsu	29	36	37	43	29	27	31	31	25	14	16	20	328
Teikoku Magnesium Company	Sakata	32	33	43	40	32	28	25	23	24	30	30	27	367
Total		274	272	263	214	187	147	198	210	212	237	182	181	2,577
Korea														
Asahi Light Metal Manufacturing Co.	Kiyo												5	5
Korea Light Metal Manufacturing Co.	Chinoampo	10	13	14	12	13	12	22	25	17	8	10	5	161
Korea Shinko Metal Manufacturing Co.	Shingishu	30	32	25	27	32	36	45	47	43	52	36	41	446
Mitsubishi Magnesium Company	Chinnampo	20	52	45	40	63	44	54	75	74	83	77	68	695
Mitsui Yushi Chemical Industrial Co.	Sanchoku			4	5	3	5	5	6	5	8	6	5	52
Nichitsu Magnesium Company	Kooan	32	45	30	58	43	47	50	50	23	40	30	29	477
Total		92	142	118	142	154	144	176	203	162	191	159	153	1,836
Manchukuo														
Manshu Magoesium Company	Eiko	45	47	30	31	28	30	32	32	34	34	27	32	402
Formosa														
Asahi Electric Industrial Compaoy	Takao	50	42	30	37	33	34	9	23	32	18	2		310
Grand total		461	503	441	424	402	355	415	468	440	480	370	366	5,125

See footnotes at end of table.

APPENDIX TABLE 28.—*Magnesium production, Japan proper, Korea, Manchukuo and Formosa, monthly, fiscal years 1943-45—Continued*

(In metric tons)

Company	Plant	1945 April	1945 May	1945 June	1945 Total[1]
Japan proper					
Asahi Electric Industrial Company	Ogu	2			2
Japan Magnesium Company	Toyama	18	26	19	63
Kanto Electric Industrial Company	Shibukawa	52	47	32	131
Rikeo Metal Manufacturing Company	Ube	26	31	26	83
Shinetsu Chemical Industrial Company	Naoetsu	21	23	40	84
Teikoku Magnesium Company	Sukata	17	16	8	41
Total		136	143	125	404
Korea					
Asahi Light Metal Manufacturing Company	Kiyo	3	12	7	22
Korea Light Metal Manufacturing Company	Chinnampo	3	4	12	19
Korea Shinko Metal Manufacturing Company	Shingishu	41	47	40	128
Mitsubishi Magnesium Company	Chinnampo	74	76	53	203
Mitsui Yushi Chemical Industrial Company	Sanchoku	8	2	5	15
Nichitsu Magnesium Company	Konan	31	35	42	108
Total		160	176	159	495
Manchukuo					
Manshu Magnesium Company	Eiko	28	33	31	92
Formosa					
Asahi Electric Industrial Company	Takao				
Grand total		324	352	315	991

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Data for July and August in the second quarter available for only two plants. Riken Metal Manufacturing Company produced 7 tons, in July and Teikoku Magnesium Company produced 6 tons in July and 1 ton in August.

Source: Bureau of Mines, Ministry of Commerce and Industry; Light Metals Control Association (KEIKINZOKU TOSEI KAI); Teikoku Magnesium Company; and Riken Metal Manufacturing Company, November 1945.

APPENDIX TABLE 29.—*Allotment of magnesium to allocation categories, quarterly, fiscal years 1943-45*

[In metric tons]

Category	1943 I	1943 II	1943 III	1943 IV	1943 Total	1944 I	1944 II	1944 III	1944 IV	1944 Total	1945 I	1945 Total
Army	55	46	49	72	222	77	62	66	37	242	23	23
Navy	55	45	49	72	221	77	62	66	37	242	23	23
Aircraft[1]	890	735	788	1,162	3,575	1,250	1,250	1,268	1,128	4,896	863	863
Indirect military and civilian	22	15	18	27	82	18	10	9	5	42	na	na
Total	1,022	841	904	1,333	4,100	1,422	1,384	1,409	1,207	5,422	(909)	(909)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Quantities for 1943 constitute estimated portion destined for aircraft of total magnesium allocated to Army and Navy categories.

Source: Light Metals Control association (KEIKINZOKU TOSEI KAI), November 1945.

APPENDIX TABLE 30.—*Typical analyses of magnesium produced in Japan proper, 1939-45*

[In per cent]

	Riken Metal Manufacturing Company							Teikoku Magnesium Company				
	Mg[1]	Si	Al	Fe	Cu	Zn	Mn	Mg[1]	Si	Al	Fe	Mn
1939	99.883	.032	.038	.018	.004	.025	.....		na	na	na	na
1940	99.830	.073	.054	.015	.005	.023	.....	.....	na	na	na	na
1941 January	99.901	.018	.028	.018	.004	.031	.....	.....	na	na	na	na
1942 January	99.912	.017	.024	.023	.006	.018	.....	.....	na	na	na	na
1943 January	99.868	.032	.050	.021	.004	.022	.....	.....	na	na	na	na
1943 July	99.863	.028	.035	.050	.004	.020	.....	99.850	.090	.024	.032	.004
1944 January	99.831	.048	.056	.042	.001	.020	.002	99.844	.051	.044	.042	.019
1944 July	99.689	.098	.128	.041	.002	.039	.003	99.838	.026	.030	.057	.049
1945 January	99.739	.060	.099	.070	.001	.030	.001	99.857	.041	.036	.042	.024
1945 May	99.550	.092	.212	.112	.003	.030	.001	99.896	.025	.016	.039	.024

na Indicates data not available.
[1] Magnesium by difference.

Source: Riken Metal Manufacturing company, and Teikoku Magnesium company, November 1945.

APPENDIX TABLE 31.—*Examples of Japanese magnesium alloy specifications*

[In per cent]

Specification	Abbreviation	Al	Mn	Zn	Impurities [1]	Mg	Minimum Tensile strength [2] Kg/mm [2]	Minimum elongation [3] per cent
Wrought								
7311	Ri 201	5.0 to 7.0	.1 to .5	1.5 max	1.0 max	Rem	22 to 26	8 to 10
7311	Ri 202	8.0 to 11.0	.1 to .5	1.0 max	1.0 max	Rem	26 to 30	5 to 7
7311	Ri 203	.5 max	.5 to 2.5	.5 max	.5 max	Rem	18 to 21	2
Sand cast [3]								
7317	Ri 501 [4]	3.5 to 6.5	.1 to .5	2.5 to 3.5	1.0 max	Rem	18	5
7317	Ri 502 A	8.0 to 11.0	.1 to .5		1.0 max	Rem	15	1
7317	Ri 502 B [4]	8.0 to 11.0	.1 to .5		1.5 max	Rem	20 to 21	3 to 1
Die cast								
7318	Ri 601	8.0 to 11.0	.1 to .5	.2 to 1.0	1.5 max	Rem		

[1] Impurity limits not given in Technical Institute specification book, but have been added in list of specifications prepared and published by Furukawa Electric company.
[2] Note is appended to specification as follows: "Magnesium alloy sand cast test pieces have tensile strength of about 70 per cent of tensile strength of forged test pieces."
[3] Minimum tensile strength and elongation requirements vary with thickness in three groups: under 40 mm, 40 to 100 mm, and over 100 mm.
[4] Ri 501 annealed at 200° to 250° C and air cooled. Ri 502B heat treated at about 400° C about 16 hours, and air cooled; and may be tempered at about 200° C for 16 hours and air cooled.

Source: "Japanese Aeronautical Specifications," Technical Institute, (GIJUTSUIN), Non-ferrous Metals, November 1944, except as noted.

APPENDIX TABLE 32.—*Summary of copper refining capacity, and of supply in Japan proper, fiscal years 1935-45*

[In metric tons]

Year	Refining capacity [1] (end of year)	Ore (copper content)			Blister copper			Electrolytic copper			Old scrap [7] (copper content)	Stocks [8] (electrolytic)	Exports [9]	Total available [10] 10+11-12
		Production [2]	Imports	Total (2 + 3)	Production [5]	Imports [6]	Total (5 + 6)	Production [5]	Imports [6]	Total (8 + 9)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(14)	(12)	(13)
1935	(78,240)	(38,414)	na	(38,414)	(50,772)	1,409	(52,181)	(54,422)	(60,897)	(115,319)	na	na	18,052	(97,267)
1936	(78,240)	(37,702)	na	(37,702)	(49,088)	2,518	(51,606)	(59,170)	(51,709)	(110,879)	na	na	12,758	(98,121)
1937	(84,240)	(36,778)	na	(36,778)	(54,796)	3,005	(57,801)	(63,836)	(72,278)	(136,114)	na	na	12,941	(123,173)
1938	(84,240)	(37,533)	na	(37,533)	(62,136)	3,587	(65,723)	(69,999)	(102,306)	(172,305)	na	na	7,026	(165,279)
1939	(87,600)	(36,742)	na	(36,742)	(61,389)	6,542	(67,931)	(70,142)	(120,251)	(190,393)	na	na	8,675	(181,718)
1940	(134,000)	73,866	na	(73,866)	92,011	7,997	100,008	108,216	(119,392)	(227,608)	26,735	na	7,765	(246,578)
1941	(135,000)	76,504	[11](11,670)	(88,174)	91,674	5,352	97,026	103,387	(38,486)	(141,873)	27,689	105,018	4,649	(164,913)
1942	(135,000)	81,068	11,378	92,446	97,302	4,511	101,813	105,137	(690)	(105,827)	14,789	53,086	2,537	(118,079)
1943	(150,600)	94,575	11,508	106,083	110,608	4,619	115,227	122,860	(2)	(122,862)	12,000	58,234	996	(133,856)
1944	(150,600)	81,433	5,503	86,936	87,172	5,106	92,278	99,265	3,910	103,115	8,923	31,554	1,374	110,664
1945 (First quarter)	(150,600)	(6,213)		(6,213)	(14,721)	554	(15,275)	(16,556)		(16,556)	na	[12]31,071	25	(16,531)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Information on all major plants not available until 1943. 1943–45 figures exclude only the capacity of plants producing electrolytic copper as a secondary product.
[2] Information for 1935–39 and 1945 was available only for 11 mines, contributing approximately fifty per cent to the total production.
[3] Data on all companies available only for 1943–44. Estimates for two plants included in 1940–42 figures. 1945 figure excludes one plant for which data are not available and includes two plants whose data probably contain July and August production.
[4] Production of the Chinnampo smelter in Korea which was shipped immediately to the Saganoseki refinery in Kyushu. No other information on imported blister available.
[5] Data available on all major plants for 1942–44 only. Production estimates included in 1940–41 data. Data prior to 1942 exclude scrap refined on toll for the Army and Navy. Indeterminant part of such scrap is excluded for 1942–44 on. Data for 1945 include two plants whose figures probably include July and August production.
[6] Imports 1935–41 adjusted to fiscal from calendar year data.
[7] Source: Mining Control association (KOZAN TOSEI KAI). Includes only scrap suitable for direct use by foundry or rolling mills.
[8] Includes Metals Distribution Control Co. (KINZOKU KAIKYU TOSEI KAISHA), Army, and Navy stocks. Army and Navy figures are estimated. Metals Distribution Control Company figure for end of year 1941 is as of 1 February 1942.
[9] Exports purport to be all shapes and fabricated products sent to points outside Japan proper. The 1942–44 planned allocations for export are much higher.
[10] Excludes stocks and an indeterminant part of production on toll for the Army and Navy which was not reported.
[11] Information available on imports from Formosa and China for the fourth quarter only.
[12] Stocks on hand 15 August 1945.

Sources: Company reports; Bureau of Mines, Ministry of Industry and Commerce; Bureau of Taxation, Ministry of Finance; Metals Distribution Control company (KINZOKU HAIKYU TOSEI KAISHA); Mining Control association (KOZAN TOSEI KAI), November 1945.

APPENDIX TABLE 33.—*Copper refinery capacity, by refinery, Japan proper, as of end of fiscal years 1935-45*

[In metric tons]

Company	Refinery	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 [1]
East Asia Mining and Industrial Co	Yokkaiichi	...	...	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Fujita Co	Kosaka	na	na	na	na	na	10,200	10,200	10,200	10,200	10,200	10,200
Furukawa Mining Co	Nikko	21,600	21,600	21,600	21,600	21,600	23,600	24,600	24,600	24,600	24,600	24,600
Ishiwara Industrial Co	Yokkaiichi	...	...	...	...	...	6,000	6,000	6,000	6,000	6,000	6,000
Japan Mining Co	Hitachi	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600
Japan Mining Co	Saganoseki	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000
Mitsubishi Mining Co	Osaka	11,040	11,040	11,040	11,040	14,400	18,000	18,000	18,000	21,600	21,600	21,600
Mitsui Mining Co	Takehara	na	na	na	na	na	na	na	na	12,000	12,000	12,000
Sumitomo Mining Co	Niihama	na	na	na	na	na	24,600	24,600	24,600	24,600	24,600	24,600
Others [2]	...	na	na	na	na	na	na	na	na	na	na	na
Total	...	(78,240)	(78,240)	(84,240)	(84,240)	(87,600)	(134,000)	(135,000)	(135,000)	(150,600)	(150,600)	(150,600)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] As of end of first quarter.
[2] In addition to production of the above refineries, production was reported for "Others". No data were made available as to their capacity.

Source: Bureau of Mines, Ministry of Commerce and Industry; Osaka and Saganoseki refinery capacity taken from company reports, November 1945.

APPENDIX TABLE 34.—*Copper production, by mine, Japan proper, fiscal years 1935-45*

[In metric tons of copper content]

Company	Mine	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Fujita Co	Hanaoka	na	na	na	na	na	4,770	3,529	4,161	4,387	4,460	na
Furukawa Mining Co	Ashio	13,082	13,684	13,030	11,410	9,918	8,891	7,712	7,923	8,123	5,444	857
Furukawa Mining Co	Iimori	841	839	848	847	692	604	538	619	991	1,249	189
Furukawa Mining Co	Kune	851	877	869	832	780	852	856	1,326	2,541	1,850	219
Ishiwara Industrial Co	Kishu	na	na	na	na	na	2,571	2,239	2,323	2,620	2,019	na
Japan Mining Co [1]	Hitachi	8,408	8,404	8,292	8,246	8,339	9,137	9,876	10,10	10,887	8,134	1,241
Japan Mining Co	Kamikita	...	...	...	...	...	...	...	1,251	4,515	7,463	814
Japan Mining Co [1]	Ogoya	1,973	1,895	1,934	1,945	2,037	1,823	1,466	1,823	1,820	1,168	137
Mitsubishi Mining Co [1]	Akenobe	1,856	2,321	2,736	2,400	2,859	3,130	3,077	3,410	3,572	2,603	442
Mitsubishi Mining Co [1]	Ikuno	2,715	2,741	2,795	2,744	2,594	2,709	2,696	2,988	2,701	2,043	312
Mitsubishi Mining Co [1]	Makimine	2,899	2,931	2,927	3,113	3,403	3,545	3,816	3,724	3,692	2,922	358
Mitsubishi Mining Co [1]	Osarizawa	5,789	4,010	3,347	5,996	6,120	6,076	6,493	7,221	10,348	7,705	1,473
Mitsubishi Mining Co	Shinshimokawa	...	...	...	...	...	...	...	...	[2] 938	...	171
Showa Mining Co	Okuki	na	na	na	na	na	1,203	1,583	2,015	2,122	1,516	na
Sumitomo Mining Co	Besshi	na	na	na	na	na	8,148	6,420	7,223	6,308	5,594	na
Other companies	Other mines	na	na	na	na	na	20,407	26,203	24,751	28,848	26,325	na
Total	...	(38,414	(37,702)	(36,778)	(37,533)	(36,742)	73,866	76,504	81,068	94,475	81,433	(6,213)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Calendar year data adjusted to fiscal for years 1935–40.
[2] June 1944—March 1945.

Source: Compiled from company reports; figures for Fujita, Ishiwara, Showa and Sumitomo and "others" supplied by Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 35.—*Copper production, by selected mines, Japan proper, monthly, fiscal years 1942-45* [1]

[In metric tons of copper content]

		1942											
Company	Mine	April	May	June	July	August	September	October	November	December	January	February	March	Total
Furukawa Mining Co	Ashio	604	590	499	738	820	685	535	566	613	643	762	868	7,923
Furukawa Mining Co	Iiomori	49	59	58	59	60	51	50	46	48	45	48	46	619
Furukawa Mining Co	Kune	87	77	55	117	188	115	115	121	91	108	144	108	1,326
Japan Mining Co	Hitachi	762	804	804	826	1,025	861	755	775	866	814	865	853	10,010
Japan Mining Co	Kamikita	...	21	52	72	108	121	134	45	20	205	234	239	1,251
Japan Mining Co	Ogoya	120	144	131	141	225	145	163	158	161	138	139	158	1,823
Mitsubishi Mining Co	Akenobe	312	301	279	306	304	275	265	272	279	252	269	296	3,410
Mitsubishi Mining Co	Ikuno	216	251	226	305	303	284	241	229	248	198	250	237	2,988
Mitsubishi Mining Co	Makimine	275	252	252	412	417	300	292	291	313	317	281	322	3,724
Mitsubishi Mining Co	Osarizawa	579	539	582	648	685	590	627	587	614	551	600	619	7,221
Mitsubishi Mining Co	Shinshimokawa	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	...	3,004	3,038	2,938	3,624	4,135	3,427	3,177	3,090	3,253	3,271	3,592	3,746	40,295

See footnotes at end of table.

APPENDIX TABLE 35.—*Copper production, by selected mines, Japan proper, monthly, fiscal years 1942-45* [1] *Continued*

[In metric tons of copper content]

1943

Company	Mine	April	May	June	July	August	September	October	November	December	January	February	March	Total
Furukawa Mining Co	Ashio	563	634	540	465	872	996	580	678	745	634	685	731	[e] 8,123
Furukawa Mining Co	Innori	45	72	67	86	103	122	79	67	90	85	79	96	991
Furukawa Mining Co	Kune	110	115	107	93	331	375	198	129	163	206	301	113	2,541
Japan Mining Co	Hitachi	825	872	889	857	940	1,090	897	830	992	821	930	941	10,887
Japan Mining Co	Kamikita	305	274	262	196	370	488	235	357	460	651	620	297	4,515
Japan Mining Co	Ogoya	144	132	124	131	215	271	151	122	141	114	135	140	1,820
Mitsubishi Mining Co	Akenobe	241	240	259	268	303	314	320	295	305	327	343	357	3,572
Mitsubishi Mining Co	Ikuno	209	222	233	236	276	280	243	238	187	205	223	219	2,801
Mitsubishi Mining Co	Makimine	276	266	260	258	416	424	315	312	316	257	258	354	3,692
Mitsubishi Mining Co	Osarizawa	760	746	825	791	934	1,228	853	799	866	806	799	941	10,348
Mitsubishi Mining Co	Shinshimokawa	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total		3,478	3,573	3,566	3,381	4,760	5,588	3,871	3,827	4,265	4,109	4,353	4,519	49,290

1944

Company	Mine	April	May	June	July	August	September	October	November	December	January	February	March	Total
Furukawa Mining Co	Ashio	498	553	504	494	707	681	315	330	343	296	280	443	5,444
Furukawa Mining Co	Innori	111	137	95	98	129	136	82	78	77	77	101	128	1,249
Furukawa Mining Co	Kune	197	142	164	87	274	358	110	73	103	106	97	139	1,850
Japan Mining Co	Hitachi	808	873	796	725	831	925	609	511	689	495	397	475	8,134
Japan Mining Co	Kamikita	706	1,067	684	500	1,312	1,410	458	355	345	368	43	215	7,463
Japan Mining Co	Ogoya	120	98	88	95	168	203	94	69	79	48	59	47	1,168
Mitsubishi Mining Co	Akenobe	305	256	276	301	325	290	157	153	159	139	120	142	2,603
Mitsubishi Mining Co	Ikuno	183	193	213	209	244	215	142	140	130	133	125	116	2,043
Mitsubishi Mining Co	Makimine	345	325	331	283	291	211	196	201	226	169	156	188	2,922
Mitsubishi Mining Co	Osarizawa	759	686	758	658	865	863	591	507	500	435	452	611	7,705
Mitsubishi Mining Co	Shinshimokawa	.....	.....	83	92	125	124	96	94	99	62	71	92	938
Total		4,032	4,330	3,992	3,542	5,271	5,416	2,850	2,491	2,750	2,348	1,901	2,596	44,519

1945

Company	Mine	April	May	June	Total
Furukawa Mining Co	Ashio	278	301	278	857
Furukawa Mining Co	Innori	51	71	67	189
Furukawa Mining Co	Kune	81	76	62	219
Japan Mining Co	Hitachi	461	438	342	1,241
Japan Mining Co	Kamikita	248	353	213	814
Japan Mining Co	Ogoya	41	61	35	137
Mitsubishi Mining Co	Akenobe	152	158	132	442
Mitsubishi Mining Co	Ikuno	92	121	99	312
Mitsubishi Mining Co	Makimine	156	105	97	358
Mitsubishi Mining Co	Osarizawa	507	522	444	1,473
Mitsubishi Mining Co	Shinshimokawa	55	54	62	171
Total		2,122	2,260	1,831	6,213

[1] Includes all mines for which monthly data were available. These contributed approximately fifty per cent to the total product, Japan proper.

Source: Compiled from company reports, November 1945.

APPENDIX TABLE 36.—*Blister copper production, by smelter, Japan proper, fiscal years 1935-45*

[In metric tons of blister copper]

Company	Smelter	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 (1st qtr.)
East Asia Mining and Industrial Co	Miyako	.....	.....	1,800	4,800	3,600	3,250	3,127	5,459	5,301	3,866	686
Fujita Co	Kosaka	na	na	na	na	na	[1] 6,000	[1] 6,000	[1] 6,300	6,922	[2] 6,183	na
Furukawa Mining Co	Ashio	[3] 12,616	11,112	14,151	13,333	11,944	11,031	11,450	12,230	12,640	7,748	1,055
Greater Japan Mining Co	Hassei	2,868	2,908	3,613	4,141	3,420	3,447	2,986	2,926	4,770	3,348	708
Ishiwara Industrial Co	Yokkaichi	.....	.....	.....	.....	.....	196	2,127	5,100	7,595	8,572	1,100
Japan Mining Co	Hitachi	10,426	9,834	10,076	10,987	10,758	12,122	13,882	13,895	14,204	9,725	1,276
Japan Mining Co	Ogoya	1,122	1,266	1,457	1,526	1,599	1,607	1,729	1,891	1,616	927	115
Japan Mining Co	Saganoseki	10,395	10,952	10,662	10,482	10,817	10,731	8,537	5,736	5,204	4,278	424
Mitsubishi Mining Co	Naoshima	7,588	8,994	10,060	11,276	12,316	13,719	14,150	14,502	14,942	11,428	2,272
Mitsubishi Mining Co	Osarizawa	5,757	4,022	2,977	5,591	6,935	6,389	7,204	7,327	9,037	6,130	1,311
Mitsui Mining Co	Hibi	na	na	na	na	na	[1] 7,100	[1] 7,100	[1] 7,500	8,328	6,630	1,167
Sumitomo Mining Co	Kunitomi	.....	.....	.....	.....	.....	417	482	540	837	1819	[4] 870
Sumitomo Mining Co	Shisakajima	na	na	na	na	na	16,036	12,982	14,296	18,212	16,518	[4] 3,737
Total		(50,772)	(49,088)	(54,796)	(62,136)	(61,389)	92,045	91,756	97,302	110,608	87,172	(14,721)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Estimated using 1943–44 data.
[2] January, February, and March 1945 estimated and added to data for other months to construct an annual total.
[3] Data taken from company report.
[4] Total probably includes July and August 1945 production.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 37.—*Blister copper production, by smelter, Japan proper, monthly, fiscal years 1942-45*

In metric tons of blister copper)

1942

Company	Smelter	April	May	June	July	August	September	October	November	December	January	February	March	Total
East Asia Mining and Industrial Co.	Miyako	317	452	359	318	441	574	473	552	515	496	477	485	5,459
Fujita Co	Kosaka	[1] 441	[1] 504	[1] 441	[1] 441	[1] 441	[1] 441	[1] 566	[1] 631	[1] 631	[1] 566	[1] 566	[1] 631	[1] 6,300
Furukawa Co	Ashio	697	845	922	787	1,028	908	1,117	1,020	1,171	1,065	1,138	1,532	12,230
Greater Japan Mining Co	Hassei	241	240	211	251	285	196	331	277	240	249	214	191	2,926
Ishiwara Industrial Co.	Yokkaichi	323	322	322	330	318	319	481	581	511	495	501	597	5,100
Japan Mining Co.	Hitachi	1,177	1,314	1,117	850	1,042	1,225	1,238	1,257	1,100	1,137	1,212	1,326	13,995
Japan Mining Co.	Ogoya	131	140	132	131	123	128	132	105	107	85	82	95	1,391
Japan Mining Co.	Saganoseki	436	433	509	417	358	426	518	588	568	599	472	432	5,736
Mitsubishi Mining Co.	Naoshima	1,091	1,293	1,030	1,055	976	663	1,406	1,627	1,558	1,018	1,270	1,581	14,502
Mitsubishi Mining Co.	Osarizawa	592	562	516	577	609	560	586	632	731	681	650	691	7,327
Mitsui Mining Co.	Hibi	[1] 525	[1] 600	[1] 525	[1] 525	[1] 525	[1] 525	[1] 675	[1] 750	[1] 750	[1] 675	[1] 675	[1] 750	[1] 7,500
Sumitomo Mining Co	Kunitomi	[2] 38	[2] 43	[2] 38	[2] 38	[2] 38	[2] 38	[2] 49	[2] 53	[2] 53	[2] 49	[2] 49	[2] 54	540
Sumitomo Mining Co.	Shisakajima	[2] 1,000	[2] 1,144	[2] 1,000	[2] 1,000	[2] 1,000	[2] 1,001	[2] 1,287	[2] 1,430	[2] 1,430	[2] 1,287	[2] 1,287	[2] 1,430	14,296
Total		7,009	7,842	7,122	6,720	7,164	6,944	8,853	9,503	9,365	8,402	8,593	9,795	97,302

1943

Company	Smelter	April	May	June	July	August	September	October	November	December	January	February	March	Total
East Asia Mining and Industrial Co	Miyako	432	417	503	461	457	326	573	451	491	278	493	419	5,301
Fujita Co	Kosaka	612	538	472	512	695	575	403	527	610	536	745	697	6,922
Furukawa Co	Ashio	1,225	1,102	835	830	1,000	1,247	757	1,041	1,326	977	1,004	1,302	12,640
Greater Japan Mining Co	Hassei	331	289	381	363	502	546	432	440	462	402	340	282	4,770
Ishiwara Industrial Co	Yokkaichi	561	540	581	560	511	552	625	725	825	700	720	755	7,595
Japan Mining Co.	Hitachi	1,235	1,205	1,206	934	1,226	1,239	1,144	1,226	1,132	1,106	1,271	1,280	14,204
Japan Mining Co.	Ogoya	126	129	118	115	157	174	155	131	130	115	132	134	1,616
Japan Mining Co.	Saganoseki	307	470	434	344	424	415	483	490	408	435	477	517	5,204
Mitsubishi Mining Co.	Naoshima	1,348	1,169	1,217	1,286	1,107	1,169	1,183	1,349	1,169	1,439	1,482	1,024	14,942
Mitsubishi Mining Co.	Osarizawa	655	651	651	602	801	811	644	801	837	853	830	901	9,037
Mitsui Mining Co	Hibi	459	384	618	565	959	1,092	558	821	733	726	720	693	8,328
Sumitomo Mining Co	Kunitomi	44	47	45	54	63	142	77	80	118	84	22	61	857
Sumitomo Mining Co	Shisakajima	1,174	978	1,901	1,876	1,752	1,764	1,548	1,570	1,640	1,766	1,669	1,574	19,212
Total		8,509	7,919	8,962	8,442	9,654	10,052	8,582	9,652	9,875	9,417	9,905	9,639	110,608

1944

Company	Smelter	April	May	June	July	August	September	October	November	December	January	February	March	Total
East Asia Mining and Industrial Co	Miyako	428	378	330	305	361	379	341	304	328	241	214	257	3,866
Fujita Co	Kosaka	603	558	380	408	533	644	539	494	524	[3] 500	[3] 450	[3] 550	[3] 6,183
Furukawa Co	Ashio	648	906	654	451	934	877	511	611	657	602	501	396	7,748
Greater Japan Mining Co.	Hassei	237	418	392	271	369	354	244	253	284	170	72	284	3,348
Ishiwara Industrial Co	Yokkaichi	831	831	821	841	825	821	725	638	550	591	597	501	8,572
Japan Mining Co	Hitachi	967	1,117	1,051	842	1,052	1,001	746	627	618	502	626	576	9,725
Japan Mining Co	Ogoya	111	103	81	79	106	126	68	80	67	29	52	25	927
Japan Mining Co	Saganoseki	413	482	368	227	300	318	319	351	398	423	362	317	4,278
Mitsubishi Mining Co.	Naoshima	1,479	1,102	1,038	562	876	945	1,097	907	568	857	736	1,261	11,428
Mitsubishi Mining Co.	Osarizawa	731	573	706	525	563	745	516	430	380	320	251	390	6,130
Mitsui Mining Co	Hibi	690	507	697	618	371	774	232	412	963	701	405	260	6,630
Sumitomo Mining Co	Kunitomi	153	123	133	141	239	287	218	164	95	88	90	88	1,819
Sumitomo Mining Co	Shisakajima	1,582	1,102	1,727	1,439	1,523	1,455	1,214	1,128	1,415	1,311	1,100	1,522	16,518
Total		8,873	8,200	8,378	6,709	8,052	8,726	6,770	6,399	6,847	6,335	5,456	6,427	87,172

1945

Company	Smelter	April	May	June	Total
East Asia Mining and Industrial Co	Miyako	237	277	172	686
Fujita Co	Kosaka	na	na	na	na
Furukawa Co	Ashio	412	389	254	1,055
Greater Japan Mining Co	Hassei	251	253	204	708
Ishiwara Industrial Co	Yokkaichi	500	450	150	1,100
Japan Mining Co.	Hitachi	459	471	346	1,276
Japan Mining Co	Ogoya	41	50	24	115
Japan Mining Co	Saganoseki	163	132	129	424
Mitsubishi Mining Co.	Naoshima	1,131	932	209	2,272
Mitsubishi Mining Co.	Osarizawa	390	401	520	1,311
Mitsui Mining Co	Hibi	245	504	418	1,167
Sumitomo Mining Co	Kunitomi	na	na	na	[4] 870
Sumitomo Mining Co	Shisakajima	na	na	na	[4] 3,737
Total		(3,829)	(3,859)	(2,426)	(14,721)

na Indicates data not available.

[1] Indicates a total for which one or more of the constituent figures are not available.

[1] Annual figures for 1942 estimated using 1943-44 data. Monthly figures derived from the estimated annual totals with reference to the trend of monthly production in other plants.

[2] Monthly figures derived from the annual total with reference to the trend of monthly production in other plants.

[3] January, February and March figures estimated on basis of production of previous months and with reference to the trend of monthly production of other plants. These data were added to the figures for April-December to construct the annual total.

[4] Totals probably include July and August production.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 38.—*Blister copper production, Korea, fiscal years 1935-45*

[In metric tons of blister copper]

Year	Chinnamposmelter[1]	Other production	Total
1935	1,409	na	(1,409)
1936	2,518	na	(2,518)
1937	3,005	na	(3,005)
1938	3,587	na	(3,587)
1939	6,542	na	(6,542)
1940	7,997	na	(7,997)
1941	5,352	na	(5,352)
1942	4,511	na	(4,511)
1943	4,619	[2] 2,627	7,246
1944	5,106	[2] 1,809	6,915
1945 First quarter	554	na	(554)

na Indicated data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Owned and operated by the Japan Mining company. Blister produced here was sent directly to the Saganoseki refinery in Kyushu.
[2] It is doubtful that these figures represent *all* other production in Korea.

Source: Report submitted to the Mining Control association by the Japan Mining Company, November 1945.

APPENDIX TABLE 39.—*Blister copper production, Chinnampo smelter, Korea, monthly, fiscal years 1942-45* [1]

[In metric tons of blister copper]

Month	1942	1943	1944	1945 (First quarter)
April	357	238	621	93
May	444	164	756	200
June	386	234	503	261
July	369	262	373	.....
August	309	191	542	.....
September	487	317	446	.....
October	367	502	491	.....
November	257	524	528	.....
December	398	491	203	.....
January	246	413	142	.....
February	495	617	227	.....
March	396	666	274	.....
Total	4,511	4,619	5,106	554

[1] Owned and operated by the Japan Mining Co. Blister produced at this plant was sent directly to the Saganoseki refinery in Kyushu.

Source: Report submitted to the Mining Control association by the Japan Mining Co., November 1945.

APPENDIX TABLE 40.—*Electrolytic copper production, by refinery, Japan proper, fiscal years 1935–4*

[In metric tons]

Company	Refinery	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 (First quarter)
East Asia Mining and Industrial Co.	Miyako	.....	.....	1,502	3,061	2,252	3,071	2,806	4,158	4,230	3,728	631
Fujita Co.	Kosaka	na	na	na	na	na	8,627	6,705	8,152	6,377	6,982	[2] 2,787
Furukawa Mining Co.	Nikko	18,132	18,995	18,105	20,558	18,839	19,013	18,367	17,951	21,587	14,366	2,243
Ishiwara Industrial Co	Yokkaichi	.....	.....	.....	.....	.....	.....	1,743	3,900	5,324	5,136	757
Japan Mining Co.	Hitachi	12,144	12,411	13,956	14,446	12,258	15,840	16,045	18,114	21,172	17,420	2,021
Japan Mining Co.	Saganoseki	10,628	14,429	17,597	15,519	19,088	19,818	17,329	11,521	17,447	14,526	2,357
Mitsubishi Mining Co.	Osaka	13,518	13,335	12,676	16,415	17,705	12,094	13,126	13,249	15,252	10,409	1,192
Mitsui Mining Co.	Takehara	na	na	na	na	na	[3] 5,900	[3] 5,700	5,407	7,567	5,760	902
Sumitomo Mining Co.	Niihama	na	na	na	na	na	20,653	18,466	16,184	23,136	19,294	[2] 3,666
Other companies	Other refineries	na	na	na	na	na	[3] 3,200	[3] 3,100	3,501	768	1,584	na
Total	.....	(54,422)	(59,170)	(63,836)	(69,999)	(70,142)	108,216	103,387	105,137	122,860	99,205	(16,556)

na Indicates data not available.

( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.
[1] Data prior to 1942 excludes scrap refined on toll for the Army and Navy; in data for 1942–44 an indeterminate part of such scrap is excluded.
[2] Figures probably include production for July and August of 1945.
[3] Estimated using 1942 data.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 41.- *Electrolytic copper production, by refinery, Japan proper, monthly, fiscal years 1942-45* [1]

[In metric tons]

Company	Refinery	1942												
		April	May	June	July	August	September	October	November	December	January	February	March	Total
East Asia Mining and Industrial Co	Miyako	258	273	305	291	277	366	410	400	432	355	390	401	4,158
Fujita Co	Kosaka	665	615	642	726	843	703	753	645	664	643	572	681	8,152
Furukawa Mining Co	Nikko	1,325	1,451	1,496	1,640	1,464	1,398	1,520	1,592	1,663	1,722	1,308	1,372	17,951
Ishiwara Industrial Co	Yokkaichi	249	253	240	250	245	255	380	400	405	402	401	420	3,900
Japan Mining Co	Hitachi	1,315	1,392	1,318	1,263	1,436	1,540	1,729	1,629	1,746	1,558	1,567	1,641	18,114
Japan Mining Co	Saganoseki	1,605	1,408	1,201	1,201	869	1,054	1,066	1,302	1,692	1,010	1,009	1,024	14,441
Mitsubishi Mining Co	Osaka	1,248	1,185	1,201	1,180	1,135	1,066	894	808	1,136	1,040	1,025	1,311	13,249
Mitsui Mining Co	Takehara	521	517	541	544	502	423	469	462	539	461	413	355	5,407
Sumitomo Mining Co	Niihama	1,201	1,109	1,151	1,434	1,675	1,680	1,542	1,431	1,371	1,100	1,286	1,201	16,184
Others		[2] 291	[2] 291	[2] 291	[2] 292	[2] 292	[2] 292	[2] 292	[2] 292	[2] 292	[2] 292	[2] 292	[2] 292	3,501
Total		8,681	8,494	8,386	8,821	8,758	8,777	9,055	8,961	9,960	8,203	8,263	8,698	105,057
		1943												
East Asia Mining and Industrial Co	Miyako	321	300	346	363	360	350	464	365	398	225	399	339	4,230
Fujita Co	Kosaka	480	531	463	401	621	601	451	451	573	603	601	601	6,377
Furukawa Mining Co	Nikko	1,748	1,800	1,855	2,001	2,000	2,000	1,553	1,680	1,480	1,820	1,847	1,803	21,587
Ishiwara Industrial Co	Yokkaichi	435	429	458	429	436	442	440	455	435	437	430	538	5,324
Japan Mining Co	Hitachi	1,608	1,706	1,726	1,724	1,848	1,843	1,835	1,782	1,784	1,722	1,740	1,854	21,172
Japan Mining Co	Saganoseki	1,301	1,248	1,208	1,211	1,266	1,463	1,361	1,610	1,593	1,440	1,810	1,936	17,447
Mitsubishi Mining Co	Osaka	1,235	1,305	1,162	1,104	1,288	1,384	1,242	1,044	1,291	1,285	1,300	1,612	15,252
Mitsui Mining Co	Takehara	301	502	518	550	663	802	689	605	800	775	612	750	7,567
Sumitomo Mining Co	Niihama	1,522	1,636	1,800	1,767	1,881	2,038	2,100	2,100	2,051	2,100	1,890	2,651	23,136
Others		[2] 64	[2] 64	[2] 64	[2] 64	[2] 64	[2] 64	[2] 64	[2] 64	[2] 64	[2] 64	[2] 64	[2] 64	768
Total		9,015	9,521	9,580	9,614	10,427	10,987	10,199	10,136	10,469	10,471	10,693	11,748	122,860
		1944												
East Asia Mining and Industrial Co	Miyako	449	387	303	331	336	396	327	310	291	178	139	281	3,728
Fujita Co	Kosaka	525	632	472	546	620	780	621	511	585	563	546	581	6,982
Furukawa Mining Co	Nikko	1,754	1,662	1,655	1,602	1,189	1,361	1,308	1,133	972	667	581	482	14,366
Ishiwara Industrial Co	Yokkaichi	540	535	547	538	535	553	500	450	302	198	208	230	5,136
Japan Mining Co	Hitachi	1,492	1,963	1,921	1,200	1,416	1,808	1,519	1,328	1,173	1,048	1,089	1,053	17,420
Japan Mining Co	Saganoseki	1,263	1,553	1,553	1,050	1,222	1,250	1,337	1,453	1,004	809	953	1,079	14,526
Mitsubishi Mining Co	Osaka	1,358	1,252	1,244	709	759	841	845	886	804	661	601	449	10,409
Mitsui Mining Co	Takehara	710	721	522	574	645	257	451	278	412	395	407	388	5,760
Sumitomo Mining Co	Niihama	2,200	1,800	2,100	1,500	2,000	1,702	1,318	1,099	1,651	1,100	1,308	1,516	19,294
Others		[2] 132	[2] 132	[2] 132	[2] 132	[2] 132	[2] 132	[2] 132	[2] 132	[2] 132	[2] 132	[2] 132	[2] 132	1,584
Total		10,833	10,637	10,449	8,182	8,854	9,080	8,358	7,580	7,326	5,751	5,964	6,191	99,205

Company	Refinery	1945			
		April	May	June	Total
East Asia Mining and Industrial Co	Miyako	221	115	295	631
Fujita Co	Kosaka	[3] 929	[3] 929	[3] 929	[3] 2,787
Furukawa Mining Co	Nikko	745	758	740	2,243
Ishiwara Industrial Co	Yokkaichi	259	322	176	757
Japan Mining Co	Hitachi	733	682	606	2,021
Japan Mining Co	Saganoseki	1,010	786	561	2,357
Mitsubishi Mining Co	Osaka	363	646	183	1,192
Mitsui Mining Co	Takehara	447	455	na	(902)
Sumitomo Mining Co	Niihama	[4] 1,222	[4] 1,222	[4] 1, 222	[3] 3,666
Others		na	na	na	na
Total		(5,929)	(5,915)	(4, 712)	(16,556)

na Indicates data not available.

( ) Figures in parenthese indicate totals for which one or more of the constituent figures are not available.

[1] Data excludes an indeterminate part of production from scrap refined on toll for the Army and Navy.

[2] Derived from annual total.

[3] Quarterly total probably includes amounts produced during July and August. Monthly totals derived from quarter's total.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 42.—*Imports of copper ore and ore concentrates to Japan proper, by country of origin, fiscal years 1941-44*

[In metric tons of copper content]

Country of origin	1941	1942	1943	1944
Philippines	2,336	3,391	6,614	1,213
Formosa	[1] (436)	4,537	4,780	4,236
China	[1] (42)	52	114	54
South America	5,307	3,398	...	...
Canada	3,579	...	...	...
Total	(11,670)	11,378	11,508	5,503

( ) Figures in parenthese indicate totals for which one or more of the constituent figures are not available.

[1] Data for only fourth quarter of fiscal year.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 43.—*Imports of electrolytic copper to Japan proper, by country of origin, fiscal years 1935-44* [1]

[In metric tons]

Year	America	Manchukuo	China	Canada	Chile	Others	Total
1935	59,753	na	na	57	na	1,087	(60,897)
1936	47,902	na	na	31	na	3,776	51,709
1937	54,221	na	na	122	na	17,935	(72,278)
1938	72,049	na	na	122	na	30,135	(102,306)
1939	117,204	75	na	93	2,879	na	(120,251)
1940	104,908	122	na	31	14,331	na	(119,392)
1941	21,153	251	na	na	17,082	na	(38,486)
1942	152	416	122	...	...	na	(690)
1943	...	na	na	...	...	2	(2)
1944	...	1	3,904	...	...	5	3,910

na Indicates data not available.

( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Years 1935-1941 adjusted to fiscal from calendar year data.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 44.—*Exports of copper by shapes, and by manufactured products, Japan proper, fiscal years 1935-45*

[In metric tons]

Types	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Shapes											
Alloys	...	...	...	...	...	...	...	...	...	[1] 182	...
Bars and rods	275	186	243	137	152	256	131	57	23	4	...
Ingot	694	7	5	19	1,112	274	49	117	71	866	...
Pipe and tube	401	554	267	222	247	155	214	78	80	32	...
Sheet	1,487	1,567	1,073	361	265	442	702	1,094	355	74	...
Strip	...	...	...	...	97	56	95	27	35	...	...
Wire	12,874	8,046	8,886	4,796	6,110	5,517	2,341	935	248	205	...
Wire cable	...	...	2,077	1,006	565	951	924	183	51	...	...
Wire rod	1,393	20	...	32	...	...	50	...	...	...	...
Others	692	2,025	143	234	11	31	1	2	115	11	[2] 25
Total shapes	17,816	12,405	12,694	6,807	8,559	7,682	4,507	2,493	978	1,374	25
Manufactured products [3]	236	353	247	219	116	83	142	44	18	...	...
Total copper exports	18,052	12,758	12,941	7,026	8,675	7,765	4,649	2,537	996	1,374	25

[1] Brass and bronze alloys. Probably contain a minimum of 70–75 per cent copper.
[2] Described only as "copper".
[3] No description of these products was available.

Source: Bureau of Taxation, Ministry of Finance, November 1945.

APPENDIX TABLE 45.—*Stocks of refined copper, Japan proper, 1941-45*

(In metric tons)

Date	Metals Distribution Control company	Army	Navy	Total
31 March 1942	[1] 42,518	20,000	42,500	105,018
31 March 1943	8,586	10,000	34,500	53,086
31 March 1944	27,734	...	30,500	58,234
31 March 1945	5,554	...	27,000	32,554
15 August 1945	3,693	...	27,378	31,071

[1] Metals Distribution Control company as of 1 February 1942.

Source: Reports from Metals Distribution Control company (KINZOKU HAIKYU TOSEI KAISHA), Army, and Navy, November 1945. Army and Navy figures were estimates.

APPENDIX TABLE 46.—*Planned allocations of refined copper to Army, Navy and other general categories, quarterly, fiscal years 1942-44* [1]

(In metric tons)

Year	Army	Navy	Indirect Military and Civilian	Aircraft	Shipping	Total
1942:						
I	na	na	na	na	na	na
II	7,750	13,515	6,049	(2)	(2)	27,314
III	8,797	15,341	6,655	(2)	(2)	30,793
IV	9,281	16,184	5,332	(2)	(2)	30,743
Total	(25,828)	(45,040)	(18,036)	(2)	(2)	(88,904)
1943:						
I	7,468	11,733	7,629	(2)	(2)	26,830
II	9,364	14,903	7,315	(2)	(2)	31,582
III	9,005	14,346	8,774	(2)	(2)	32,125
IV	8,668	13,811	7,008	(2)	(2)	29,487
Total	34,505	54,793	30,726	(2)	(2)	120,024
1944:						
I	3,832	4,535	4,795	8,845	5,183	27,190
II	4,297	5,103	3,982	8,000	4,560	25,942
III	3,711	4,428	4,130	6,355	3,761	22,385
IV	2,979	3,587	3,021	5,154	3,418	18,159
Total	14,819	17,653	15,928	28,354	16,922	93,676
Grand total	75,152	117,486	64,690	28,354	16,922	302,604

[1] The planned allocation figures are quarterly revisions of a yearly overall allocation plan made by the Central Mobilization bureau (SODOIN KYOKU) in formulating its Materials Mobilization Plan.

[2] Aircraft included in Army and Navy allocations and Shipping included in Navy allocations prior to 1944.

Source: Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 47.—*Navy distribution of copper to specific uses, fiscal years 1940-45*

(In metric tons)

	1940	1941	1942	1943	1944	1945 (First half)
General Navy Use						
Guns and ammunition	18,400	21,600	19,600	19,840	19,228	5,530
Torpedo mines	2,300	2,700	2,450	2,480	2,403	690
Radio and electrical	11,500	13,500	12,250	12,400	12,081	3,454
Optical and navigational	460	540	490	496	480	138
Shipbuilding	2,300	2,700	2,450	2,480	2,403	690
Engines	9,200	10,800	9,800	9,920	9,614	2,762
Equipment	1,840	2,160	1,960	1,984	1,926	552
Total distributed to General Navy Use	46,000	54,000	49,000	49,600	48,135	13,816
Aircraft Use						
Frames	899	1,011	1,181	1,738	29	10
Engines	1,199	1,516	1,351	1,759	33	12
Guns and bombs	9,448	10,615	10,138	14,905	235	89
Electrical instruments	1,200	1,111	843	1,240	21	8
Optical instruments and gauges	149	167	169	247	4	1
Base construction machinery	1,197	1,498	1,860	2,730	33	14
Construction repairing material	905	932	1,358	2,225	20	4
Total distributed to aircraft	14,997	16,850	16,900	24,844	375	138
Grand total	60,997	70,850	65,900	74,444	48,510	13,954

Source: Navy Department, November 1945.

APPENDIX TABLE 48.—*Planned allocations of refined copper to indirect military and civilian categories, quarterly, fiscal years 1942-44*

[In metric tons]

Category	1942				1943					1944				
	II	III	IV	Total	I	II	III	IV	Total	I	II	III	IV	Total
Specific indirect military and civilian demands														
Iron and steel	226	213	180	619	684	529	162	355	1,730	154	190	143	84	571
Coal mining	313	352	403	1,068	486	374	422	505	1,787	293	...	293	121	707
Light metal	113	129	101	343	1,191	525	1,225	382	3,323	141	175	235	168	719
Metal mining	216	264	214	694	190	297	422	222	1,131	358	155	203	84	800
Electric power	792	871	678	2,341	444	581	591	523	2,139	130	53	55	26	264
Liquid fuel	86	100	74	260	223	242	123	102	690	49	39	50	210	348
Machine industry	498	576	444	1,518	565	730	725	652	2,672	315	19	171	41	546
Automobile	95	107	84	286	47	68	65	60	240	133	132	71	35	371
Metal industry	...	...	...	...	...	...	...	...	...	4	5	7	7	23
Chemical industry	65	69	54	188	51	124	384	142	701	60	118	185	154	517
Others	...	...	...	...	...	...	...	...	...	18	4	11	8	41
Total specific demands	2,404	2,681	2,232	7,317	3,881	3,470	4,119	2,943	14,413	1,655	890	1,424	938	4,907
Official demands	404	482	373	1,259	316	386	408	505	1,615	200	93	118	58	469
General civilian demands	853	647	587	2,087	904	635	657	596	2,792	867	1,060	779	591	3,297
Exports to colonies	851	919	698	2,468	518	722	1,168	1,058	3,466	542	397	330	215	1,484
Export	954	1,252	995	3,201	1,871	1,711	1,702	1,492	6,776	930	1,187	1,087	555	3,759
Others	583	674	447	1,704	139	391	720	414	1,664	601	355	392	664	2,012
Grand total	6,049	6,655	5,332	18,036	7,629	7,315	8,774	7,008	30,726	4,795	3,982	4,130	3,021	15,928

[1] The allocation figures are quarterly revisions of yearly over-all allocations made by the General Mobilization bureau.

Source: Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 49.—*Contracted and actual deliveries of refined copper by the Metals Distribution Control company, quarterly, fiscal year 1942-45* [1]

[In metric tons]

Year	Contracted deliveries					Total actual deliveries from warehouses
	Army	Navy	Indirect military and civilian	Aircraft	Total	
1942:						
IV	8,925	19,626	5,828	(2)	34,379	10,283
1943:						
I	6,260	14,313	6,629	(2)	27,202	31,522
II	9,228	12,185	4,676	(2)	26,089	28,820
III	11,469	20,914	3,151	(2)	35,534	32,021
IV	9,724	16,698	3,309	(2)	29,731	27,673
Total	36,681	64,110	17,765	(2)	118,556	120,036
1944:						
I	5,308	16,589	11,801	3,716	37,414	35,512
II	4,590	17,994	15,032	10,543	48,159	44,393
III	5,285	11,718	4,143	8,725	29,871	31,088
IV	3,787	5,554	359	3,622	13,322	22,982
Total	18,970	51,855	31,335	26,606	128,766	133,975
1945:						
I	702	3,352	449	2,768	7,271	8,505
II	533	675	915	599	2,722	na
Total	1,235	4,027	1,364	3,367	9,993	(8,505)
Grand total	65,811	139,618	56,292	29,973	291,694	(272,799)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Data not available prior to the fourth quarter of 1942. Records destroyed.
[2] Contracted deliveries to Aircraft were included under Army and Navy prior to 1944.

Source: Metals Distribution Control company (Kinzoku Haikyu Tosei Kaisha) November 1945.

APPENDIX TABLE 50.—*Summary of Japanese total lead producing capacity and supply, fiscal years 1935–45*

[In metric tons of metal content]

Year	Capacity						Total supply															
	Japan proper		Korea and Manchukuo		Total		Japan proper									Korea and Manchukuo				Total imports to Japan proper	Total production of crude lead Japan proper and overseas	Total production of refined lead
							Ore and concentrates			Crude lead			Refined lead									
	Smelters	Refineries[2]	Smelters[3]	Refineries[4]	Smelters	Refineries	Production	Imports	Total	Production	Imports[6]	Total	Production	Imports	Total	Crude[9] production	Refined[11] production	Scrap[12] production	Stock piles[13]			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1935	na	(14,200)	na	na	na	(14,200)	na	na	na	na	na	na	7,807	[8] 90,206	98,013	(1,338)	na	na	na	(90,206)	na	(7,807)
1936	na	(19,900)	na	na	na	(19,900)	na	na	na	na	na	na	10,601	[8] 95,921	106,522	(3,143)	na	na	na	(95,921)	na	(10,601)
1937	na	(29,200)	na	na	na	(29,200)	na	na	na	na	na	na	15,813	[8] 59,235	75,048	(6,156)	na	na	na	(59,235)	na	(15,813)
1938	na	(29,200)	na	na	na	(29,200)	na	na	na	na	na	na	16,283	[8] 60,263	76,546	(5,402)	na	na	na	(60,263)	na	(16,283)
1939	na	(29,200)	na	na	na	(29,200)	na	na	na	na	na	na	14,223	[8] 100,802	15,025	(7,786)	na	na	na	(100,802)	na	(14,223)
1940	37,380	(36,400)	(13,000)	na	(50,380)	(36,400)	(11,654)	na	(11,654)	(13,727)	(10,200)	(23,927)	23,531	[8] 92,091	15,622	(10,294)	na	na	na	(102,291)	(24,021)	(23,531)
1941	37,380	(36,400)	(13,000)	na	(50,380)	(36,400)	15,139	na	(15,139)	15,507	(10,500)	(26,007)	26,734	[8] 78,532	105,266	(10,521)	na	na	na	(89,032)	(26,028)	(26,734)
1942	37,380	(36,400)	(13,000)	na	(50,380)	(36,400)	19,636	3,648	23,284	16,489	(8,200)	(24,689)	25,832	4,328	30,160	(8,232)	4,654	na	2,42	(16,176)	(24,721)	(30,486)
1943	37,380	53,800	(20,000)	na	(57,380)	(53,800)	22,706	142	22,848	21,236	16,100	37,336	32,031	10,214	42,245	[10] (18,352)	4,607	2,436	[14] 99,743 3/31/44	na	26,456	(39,588)	(36,638)
1944	37,380	53,800	(20,000)	na	(57,380)	(53,800)	17,344	257	17,601	20,227	14,200	34,427	34,930	3,136	38,066	[10] (16,229)	2,208	21,982	56,887 8/15/45	17,593	(36,456)	(37,138)
1945[1]	37,380	53,800	(20,000)	na	(57,380)	(53,800)	[5] (2,376)		(2,376)	3,105	(924)	(4,029)	[7] (4,009)		(4,009)	(924)	na	na	28,900	(924)	(4,029)	(4,009)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] April 1–August 15.
[2] Capacity before 1943 does not include the Takehara refinery for which the data are not available.
[3] Estimate of Korean capacity based on charging capacity. Manchukuo data not available.
[4] Manchukuo data not available.
[5] Production of the two largest mines estimated at over 50 per cent of total production.
[6] Estimated by Japan Mining company. Includes all Chinnampo smelter production and 80 per cent of remaining production. All crude lead imports were from Korea.
[7] Data on Saganoseki, Takehara and "other" refineries incomplete.
[8] Calendar years.
[9] Manchukuo production not available. With the exception of the years 1943–44, these figures represent production of the Chunnampo smelter in Korea.
[10] Total Korean production.
[11] Korea has no refining capacity. Manchukuo data are unavailable, except for years shown. Data for 1944 probably include no more than 8 months.
[12] Allocated as sorted or remelted scrap. Deductions are already made on the basis of the estimate of the Bureau of Mines that 20 per cent returned to the refineries and 5 per cent was lost in the remelt.
[13] Sum of the refined metal stocks held by the Metals Distribution Control company, Army and Navy. The Army and Navy figures are estimated by those organizations.
[14] Includes estimates of Army and Navy stocks for March 31, 1942 instead of February 1942.

Source: Japan Proper data mainly from Bureau of Mines, Ministry of Commerce and Industry, November 1945. For Korean data Japan Mining company, November 1945. Japanese Army and Navy supplied stockpile data, November 1945. For specific sources, refer to the Appendix Tables from which the above material was taken.

APPENDIX TABLE 51.—*Lead smelter capacity in Japan proper, Korea, and Manchukuo, by plant, fiscal years 1940–45*

[In metric tons of metal content]

Company	Name	1940	1941	1942	1943	1944	1945
Japan proper							
Japan Soda Co.	Aizu	5,580	5,580	5,580	5,580	5,580	5,580
Mitsubishi Mining Co.	Hosokura	14,400	14,400	14,400	14,400	14,400	14,400
Mitsui Mining Co.	Kamioka	17,400	17,400	17,400	17,400	17,400	17,400
Total		37,380	37,380	37,380	37,380	37,380	37,380
Korea							
Japan Mining Co.	Chinnampo[1]	13,000	13,000	13,000	13,000	13,000	13,000
Others		na	na	na	7,000	7,000	7,000
Total		(13,000)	(13,000)	(13,000)	20,000	20,000	20,000
Manchukuo[2]		na	na	na	na	na	na
Grand total		(50,380)	(50,380)	(50,380)	(57,380)	(57,380)	(57,380)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] Estimate based on charging capacity.
[2] Presumably enough smelter capacity to match the refinery capacity of the two reported refineries.

Source: Information on Japan proper was supplied by the Bureau of Mines, Ministry of Commerce and Industry; Korean data by the Japan Mining Co., November 1945.

APPENDIX TABLE 52.—*Lead refinery capacity in Japan proper and Manchukuo, by plant, fiscal years 1935–45*

[In metric tons of metal content]

Company	Name	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Japan proper												
Japan Mining Co.	Suganoseki	1,800	7,500	13,200	13,200	13,200	13,200	13,200	13,200	13,200	13,200	13,200
Japan Soda Co.	Aizu						1,200	1,200	1,200	3,600	3,600	3,600
Mitsubishi Mining Co.	Hosokura	2,400	2,400	6,000	6,000	6,000	12,000	12,000	12,000	12,000	12,000	12,000
Mitsui Mining Co.	Kamioka	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Mitsui Mining Co.	Takohara	na	na	na	na	na	na	na	na	15,000	15,000	15,000
Total		(14,200)	(19,900)	(29,200)	(29,200)	(29,200)	(36,400)	(36,400)	(36,400)	53,800	53,800	53,800
Manchukuo												
	Koroto	na	na	na	na	na	na	na	na	na	na	na
	Mukden	na	na	na	na	na	na	na	na	na	na	na
Grand total		(14,200)	(19,900)	(29,200)	(29,200)	(29,200)	(36,400)	(36,400)	(36,400)	(53,800)	(53,800)	(53,800)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

Source: Information on Japan proper was supplied by the Bureau of Mines, Ministry of Commerce and Industry; Manchukuo data by the Manchurian Industrial Development Corporation, November 1945.

APPENDIX TABLE 53.—*Lead ore production in Japan proper, by mine, fiscal years 1935–45*

[In metric tons of lead concentrates]

Company	Mine	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 (April–August)
Mitsubishi Mining Co.	Hosokura	[1]3,026	[1]5,086	[1]6,207	[1]6,597	[1]6,290	[2]7,399	6,875	6,469	6,992	6,263	1,625
Mitsui Mining Co.	Kamioka	4,264	5,377	5,740	6,459	6,241	7,179	7,698	9,321	10,819	9,859	2,235
Others		na	na	na	na	na	[3]9,744	[3]15,127	[3]17,616	[3]20,416	[3]12,814	na
Total		(7,290)	(10,463)	(11,947)	(13,056)	(12,531)	24,322	29,700	33,406	38,227	28,936	(3,860)

[In metric tons of metal content]

Mitsubishi Mining Co.	Hosokura	na	na	na	na	na	2,578	2,754	3,806	4,495	4,112	1,080
Mitsui Mining Co.	Kamioka	na	na	na	na	na	3,411	3,590	5,588	6,341	5,782	[4]1,296
Others							5,665	8,795	10,242	11,870	7,450	na
Total		na	na	na	na	na	11,654	15,139	19,636	22,706	17,344	(2,376)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] Calendar year production.
[2] Calendar year 1940 plus January–March, 1941.
[3] Estimated from metal content figures on the basis of an average 58 per cent Pb content.
[4] Estimated.

Source: Bureau of Mines, Ministry of Commerce and Industry for metal content figures; Mitsubishi Mining Co. and Mitsui Mining Co. for concentrate figures November 1945.

APPENDIX TABLE 54.—*Production of lead concentrates in Japan proper, by mine, monthly, fiscal years 1942-45*

[In metric tons of concentrates]

1942

Company	Mine	April	May	June	July	August	September	October	November	December	January	February	March	Total
Mitsubishi Mining Co.	Hosokura	553	514	574	746	579	488	450	402	579	515	537	532	6,469
Mitsui Mining Co.	Kamioka	na	na	na	na	na	na	na	na	na	na	na	na	9,321
Others		na	na	na	na	na	na	na	na	na	na	na	na	[1]17,616
Total		(553)	(514)	(574)	(746)	(579)	(488)	(450)	(402)	(579)	(515)	(537)	(532)	33,406

1943

Company	Mine	April	May	June	July	August	September	October	November	December	January	February	March	Total
Mitsubishi Mining Co.	Hosokura	572	537	541	504	729	850	626	533	547	501	523	529	6,992
Mitsui Mining Co.	Kamioka	578	874	865	847	983	1,364	921	854	862	794	896	981	10,819
Others		na	na	na	na	na	na	na	na	na	na	na	na	[1]20,416
Total		(1,150)	(1,411)	(1,406)	(1,351)	(1,712)	(2,214)	(1,547)	(1,387)	(1,409)	(1,295)	(1,419)	(1,510)	38,227

1944

Company	Mine	April	May	June	July	August	September	October	November	December	January	February	March	Total
Mitsubishi Mining Co.	Hosokura	647	582	485	354	668	1,045	517	366	323	425	399	452	6,263
Mitsui Mining Co.	Kamioka	821	965	929	828	1,007	1,278	932	694	713	685	520	487	9,859
Others		na	na	na	na	na	na	na	na	na	na	na	na	[1]2,814
Total		(1,468)	(1,547)	(1,414)	(1,182)	(1,675)	(2,323)	(1,449)	(1,060)	(1,036)	(1,110)	(919)	(939)	28,936

1945

Company	Mine	April	May	June	July	August	September	October	November	December	January	February	March	Total
Mitsubishi Mining Co.	Hosokura	395	469	395	306	60								1,625
Mitsui Mining Co.	Kamioka	454	461	501	565	254								2,235
Others		na	na	na	na	na								na
Total		(849)	(930)	(896)	(871)	(314)								(3,860)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] Estimated from metal content figures on the basis of an average 58 per cent Pb content supplied by the Bureau of Mines, Ministry of Commerce and Industry.

Source: Mitsubishi Mining company, and Mitsui Mining company, November 1945.

APPENDIX TABLE 55.—*Production of crude lead in Japan proper, Korea, and Manchukuo, by smelter, fiscal years 1940-45*

[In metric tons of metal content]

Company	Name	1940	1941	1942	1943	1944	1945 (April-August)
Japan proper							
Japan Soda Co.	Aizu	622	1,160	859	1,584	2,464	469
Mitsubishi Mining Co.	Hosokura	7,500	7,430	7,560	10,415	9,720	1,430
Mitsui Mining	Kamioka	5,605	6,917	8,070	9,237	8,043	1,206
Total		13,727	15,507	16,489	21,236	20,227	3,105
Korea							
Japan Mining Co.	Chinnampo	10,294	10,521	8,232	7,423	6,414	[1](924)
Others		na	na	na	10,929	9,815	na
Total		(10,294)	(10,521)	(8,232)	18,352	16,229	(924)
Manchukuo[2]		na	na	na	na	na	na
Grand total		(24,021)	(26,028)	(24,721)	(39,588)	(36,456)	(4,029)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] April-June 1945.
[2] Manchukuo produced at least as much crude lead as was refined in Manchukuo. Manchukuo production of lead concentrated (Pb content) was as follows: 1940—4,707; 1941—5,710; 1942—6,257; 1943—11,966. How much of this was smelted or refined is not known.

Source: Bureau of Mines, Ministry of Commerce and Industry; Japan Mining Co., for data on Korea. November 1945.

APPENDIX TABLE 56. *Production of crude lead in Japan proper, by smelter, monthly, fiscal years 1942-45*

[In metric tons of metal content]

Company	Name	April	May	June	July	August	September	October	November	December	January	February	March	Total
		1942												
Japan Soda Co.	Aizu	79	65	98	73	59	34	67	68	79	72	64	101	859
Mitsubishi Mining Co	Hosokura	na	na	na	na	na	na	na	na	na	na	na	na	7,560
Mitsui Mining Co	Kamioka	na	na	na	na	na	na	na	na	na	na	na	na	8,070
Total		(79)	(65)	(98)	(73)	(59)	(34)	(67)	(68)	(79)	(72)	(64)	(101)	16,489
		1943												
Japan Soda Co.	Aizu	74	24	101	106	177	234	165	128	142	133	143	157	1,584
Mitsubishi Mining Co	Hosokura	698	719	769	869	824	959	938	960	1,073	710	969	927	10,415
Mitsui Mining Co.	Kamioka	910	770	852	759	747	736	774	781	750	566	797	795	9,237
Total		1,682	1,513	1,722	1,734	1,748	1,929	1,877	1,869	1,965	1,409	1,909	1,879	21,236
		1944												
Japan Soda Co	Aizu	215	289	203	290	311	286	191	222	224	93	60	80	2,464
Mitsubishi Mining Co.	Hosokura	753	933	933	673	814	723	765	933	779	804	765	845	9,720
Mitsui Mining Co.	Kamioka	704	673	830	714	725	739	755	714	662	537	488	502	8,043
Total		1,672	1,895	1,966	1,677	1,850	1,748	1,711	1,869	1,665	1,434	1,313	1,427	20,227
		1945												
Japan Soda Co.	Aizu	96	82	84	146	61								469
Mitsubishi Mining Co.	Hosokura	na	na	na	na	na								1,430
Mitsui Mining Co.	Kamioka	386	419	401	na	na								(1,206)
Total		(482)	(501)	(485)	(146)	(61)								(3,105)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 57.—*Production of crude lead in the largest Korean smelter, annually, fiscal years 1931–41, monthly, fiscal years 1942–45* [1]

[In metric tons of metal content]

Year	Total	Year	Total
1931	95	1937	6,156
1932	718	1938	5,402
1933	992	1939	7,786
1934	883	1940	10,294
1935	1,338	1941	10,521
1936	3,143		

Month	1942	1943	1944	1945
April	455	680	614	255
May	518	312	650	324
June	579	503	631	345
July	626	721	691	
August	636	632	519	
September	935	633	620	
October	977	825	508	
November	611	683	636	
December	580	778	365	
January	504	645	381	
February	619	511	691	
March	737	506	398	
Total	8,232	7,423	6,414	924

[1] Japan Mining Co, Chunnampo smelter, Chinnampo.

Source: Japan Mining Co, November 1945.

APPENDIX TABLE 58.—*Production of refined lead in Japan proper and Manchukuo, by refinery, fiscal years 1935-45*

[In metric tons]

Company	Refinery	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 (Apr.-Aug.)
Japan proper												
Japan Mining Co.	Saganoseki	1,044	2,218	6,199	5,729	6,216	9,804	11,227	8,106	10,821	10,625	(530)
Japan Soda Co.	Aizu	...	...	...	...	...	603	1,125	730	1,504	2,696	418
Mitsubishi Mining Co.	Hosokura	1,692	2,882	4,086	5,364	2,728	7,058	6,984	7,107	8,113	7,343	1,361
Mitsui Mining Co.	Kamioka	5,071	5,501	5,528	5,190	5,279	5,190	6,380	7,270	8,158	8,666	1,790
Mitsui Mining Co.	Takehara	na	na	na	na	na	876	1,018	2,619	2,898	5,600	na
Others		na	na	na	na	na				537	...	na
Total		(7,807)	(10,601)	(15,813)	(16,283)	(14,223)	23,531	26,734	25,832	32,031	34,930	(4,099)
Manchukuo												
	Mukden	...	...	...	na	na	na	na	4,654	4,607	[1] (2,208)	na
	Koroto	...	...	...	...	...	...	...	...	...	...	...
Grand total		(7,807)	(10,601)	(15,831)	(16,283)	(14,223)	(23,531)	(26,734)	30,486	36,638	(37,138)	(4,099)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] Probably does not include more than eight months.

Sources: Information on Japan proper supplied by Bureau of Mines, Ministry of Commerce and Industry; Manchukuo data from *Data on Manchuria prepared for the 80th session of the Japanese Diet (23 December 1944-13 February 1945)* Ministerial Secretariat, Archives Section, Manchurian Affairs Bureau Greater East Asia Ministry. Translated by the United States Strategic Bombing Survey.

APPENDIX TABLE 59.—*Production of refined lead in Japan proper, by refinery, monthly, fiscal years 1942-45*

[In metric tons]

1942

Company	Refinery	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Japan Mining Co.	Saganoseki	377	644	843	757	633	29	698	701	1,070	876	349	1,129	8,106
Japan Soda Co.	Aizu	77	62	94	70	57	32	65	66	53	40	41	73	730
Mitsubishi Mining Co.	Hosokura	500	500	501	700	651	600	620	600	600	610	605	620	7,107
Mitsui Mining Co.	Kamioka	na	na	na	na	na	na	na	na	na	na	na	na	7,270
Mitsui Mining Co.	Takehara	na	na	na	na	na	na	na	na	na	na	na	na	2,619
Others		na	na	na	na	na	na	na	na	na	na	na	na	
Total		(954)	(1,206)	(1,438)	(1,527)	(1,341)	(661)	(1,383)	(1,367)	(1,723)	(1,526)	(995)	(1,822)	25,832

1943

Company	Refinery	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Japan Mining Co.	Saganoseki	563	843	696	943	683	628	1,064	954	1,000	1,252	1,167	1,028	10,821
Japan Soda Co.	Aizu	93	82	94	217	122	138	118	85	110	151	142	152	1,504
Mitsubishi Mining Co.	Hosokura	525	601	603	602	710	835	700	691	710	710	700	726	8,113
Mitsui Mining Co.	Kamioka	563	593	695	683	752	784	723	701	701	569	675	619	8,158
Mitsui Mining Co.	Takehara	151	159	159	135	202	305	324	271	288	301	301	302	2,898
Others		na	na	na	na	na	na	na	na	na	na	na	na	537
Total		(1,895)	(2,278)	(2,247)	(2,580)	(2,469)	(2,690)	(2,929)	(2,702)	(2,809)	(2,983)	(2,985)	(2,927)	32,031

1944

Company	Refinery	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Japan Mining Co.	Saganoseki	896	747	1,142	1,076	956	996	843	1,003	1,017	941	402	606	10,625
Japan Soda Co.	Aizu	201	188	251	281	332	339	296	296	230	150	56	76	2,696
Mitsubishi Mining Co.	Hosokura	820	750	631	586	891	925	560	650	450	450	330	300	7,343
Mitsui Mining Co.	Kamioka	702	730	751	751	801	800	800	800	761	701	551	518	8,666
Mitsui Mining Co.	Takehara	310	371	450	450	270	659	524	371	516	589	545	545	5,600
Others		...	...	...	...	...	...	...	...	...	...	...	...	...
Total		2,929	2,786	3,225	3,144	3,250	3,719	3,023	3,120	2,974	2,831	1,884	2,045	34,930

1945

Company	Refinery	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Japan Mining Co.	Saganoseki	370	...	160	na	na	...	...	...	...	...	...	...	(530)
Japan Soda Co.	Aizu	39	33	69	143	134	...	...	...	...	...	...	...	418
Mitsubishi Mining Co.	Hosokura	300	301	320	310	130	...	...	...	...	...	...	...	1,361
Mitsui Mining Co.	Kamioka	521	502	364	302	101	...	...	...	...	...	...	...	1,790
Mitsui Mining Co.	Takehara	na	na	na	na	na	...	...	...	...	...	...	...	na
Others		...	...	...	...	...	...	...	...	...	...	...	...	...
Total		(1,230)	836	(913)	(755)	(365)	...	...	...	...	...	...	...	(4,099)

na Indicates data not available
( ) Indicates total for which one or more of the constituent figures are not available.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 60.—*Imports of lead concentrates to Japan proper, by country of origin, quarterly, fiscal years 1942–45*

[In metric tons of metal content]

Year	Manchukuo	Korea	Hong Kong	French Indochina	Total
1942:					
I	282	151			433
II					
III					
IV	3,203			12	3,215
Total	3,485	151		12	3,648
1943:					
I					
II					
III			142		142
IV					
Total			142		142
1944:					
I			257		257
II					
III					
IV					
Total			257		257
1945					

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 61.—*Imports of refined lead to Japan proper, by country of origin, 1935–45*

[In metric tons]

Year	Manchukuo	China	India	England	Straits Settlements	United States	Canada	Australia	Mexico	Burma	Others	Total
1935 [1]			20,367	33		23,405	31,504	1,943			12,954	90,206
1936		12	13,047	85		9,407	43,476	759			29,126	95,912
1937		63				4,641	25,122				29,409	59,235
1938		178				14,429	7,156				38,500	60,263
1939	258	23				38,279	42,631	1,066	1,626	16,818	102	100,803
1940	80					26,626	26,366	9,585	21,559	7,367	508	92,091
1941	651	22				8,159		2,275	58,157	9,268		78,532
1942 [2]	1,950	25			40					2,270	43	4,328
1943	1,862				8,350						2	10,214
1944	1,166	1,398			220					330	22	3,136
1945												

[1] Calendar years 1935–1941.
[2] 1942–1945 fiscal years; 1942 fiscal year includes January-March 1942.

Sources: Bureau of Mines, Ministry of Commerce and Industry; for information on imports from the Straits Settlements and Burma during the war, the Japanese Army and Navy, November 1945.

APPENDIX TABLE 62.—*Exports of lead from Japan proper, fiscal years 1935–45* [1]

[In metric tons]

	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 (First half)
Lead pipe	1,417	1,469			256	141	111	18	49		
Lead plate	467	864									
Lead sheet			717	1,105	1,031	96	31	46	11		
Lead tube			1,023	588							
Manufactures	na	na									
Others			252	162	96	821	186	367			
Total	(1,884)	(2,333)	1,992	1,855	1,383	1,058	328	431	60	43	10

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] Includes exports from Japan proper, Korea and Formosa.

Source: Bureau of Taxation, Ministry of Finance, November 1945.

APPENDIX TABLE 63. *Stock piles of lead in Japan proper, 1941–45*

[In metric tons]

Period	Metals Distribution Control Co	Army [1]	Navy [1]	Total
2 February 1942	55,389	[2] 20,000	[2] 24,354	99,743
31 March 1943	na	30,000	19,854	(49,354)
31 March 1944	27,533	15,000	14,354	56,887
15 August 1945	10,962	10,000	7,938	28,900

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] Estimated by the Army and Navy.
[2] For 31 March 1942. Stocks are believed to be at least this large on 7 December 1941.

Source: Metals Distribution Control Co. (Kinzoku Haikyu Tosei Kaisha) Army and Navy, November 1945.

APPENDIX TABLE 64. *Total Japanese allocations of lead to Army, Navy, and other general categories, quarterly, fiscal years 1942-44*

[In metric tons of metal content]

Category	1942					1943					1944				
	I	II	III	IV	Total	I	II	III	IV	Total	I	II	III	IV	Total
Army	na	4,375	4,294	3,864	(12,533)	2,002	1,642	3,023	2,863	9,530	2,187	2,312	1,900	1,753	8,152
Navy	na	7,605	7,734	6,958	(22,297)	4,366	3,980	5,912	5,416	19,674	3,480	4,258	3,729	3,424	14,891
Indirect military and civilian	na	6,421	6,766	6,410	(19,597)	5,074	5,850	4,419	4,950	20,293	3,964	3,210	2,834	2,129	12,137
Aircraft [1]											2,459	2,100	1,738	1,200	7,497
Shipping [1]											1,475	1,260	983	1,025	4,743
Special use													,600	1,400	4,000
Total	na	18,401	18,794	17,232	(54,427)	11,442	11,472	13,354	13,229	49,497	13,565	13,140	13,784	10,931	51,420

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.
[1] Aircraft and shipping allocations had been included in Army and Navy categories prior to 1944.

Source: Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 65.—*Navy distribution of lead to specific uses, fiscal years 1940–45*

(In metric tons)

Category	1940	1941	1942	1943	1944	1945 (to end of war)
General Navy use						
Guns and ammunition	676	590	485	509	490	170
Torpedoes and mines	680	580	491	510	510	185
Electrical equipment	26,045	22,715	18,788	19,608	19,025	6,546
Optical and navigational instruments	340	295	244	254	247	85
Shipbuilding	5,073	4,425	3,660	3,820	3,706	1,275
Other equipment	1,011	895	732	777	730	239
Total	33,825	29,500	24,400	25,478	24,708	8,500
Aircraft use						
Aircraft frames	438	356	275	272	44	5
Aircraft engines	526	419	218	278	42	6
Guns and bombs	614	423	216	408	62	8
Electrical instruments	5,352	4,340	3,410	4,233	541	78
Optical instruments and gauges	351	218	165	204	25	3
Base construction machinery	780	698	660	752	86	9
Construction, repairing materials	714	546	556	682	83	12
Total	8,775	7,000	5,500	6,829	883	121
Grand total	42,600	36,500	29,900	32,307	25,591	8,621

Source: Japanese Navy, November 1945.

APPENDIX TABLE 66.—*Japanese planned allocations of lead to indirect military and civilian uses, quarterly, fiscal years 1942–44*

[In metric tons]

Category	1942					1943					1944				
	I	II	III	IV	Total	I	II	III	IV	Total	I	II	III	IV	Total
Specific indirect military and civilian demands[1]															
Iron and steel	na	128	121	99	(348)	333	138	39	156	666	76	88	46	28	238
Coal mining	na	306	320	380	(1,006)	401	232	208	338	1,179	154		197	80	431
Light metals	na	88	92	76	(256)	247	645	381	171	1,444	290	501	331	426	1,548
Metal mining	na	571	613	504	(1,688)	490	701	531	425	2,156	503	409	195	83	1,190
Electric power	na	379	546	327	(1,252)	239	211	58	305	813	143	30	35	25	233
Liquid fuel	na	109	113	96	(318)	151	299	97	89	636	35	9	15	33	92
Machine tools	na	266	201	217	(684)	309	337	305	252	1,203	34	2	33	11	80
Automobiles	na	99	121	98	(318)	74	96	69	60	299	296	115	103	57	571
Metals	na				na						16		2	2	20
Chemicals	na	433	452	383	(1,268)	360	327	415	315	1,417	190	206	217	71	684
Others	na				na						3	1	1	1	6
Total	na	2,379	2,579	2,180	(7,138)	2,613	2,986	2,103	2,111	9,813	1,740	1,361	1,175	817	5,093
Official demands	na	482	519	429	(1,430)	374	321	384	328	1,407	176	139	130	93	538
General civilian demands	na	775	857	1,003	(2,635)	664	743	610	732	2,749	546	554	561	266	1,927
Exports to colonies	na	848	851	743	(2,442)	574	472	169	668	1,883	455	330	274	184	1,243
Exports	na	569	605	494	(1,668)	155	807	565	539	2,066	432	514	313	124	1,383
Others	na	1,568	1,355	1,561	(4,284)	694	521	588	572	2,375	615	312	381	645	1,953
Grand total	na	6,421	6,766	6,410	(19,597)	5,074	5,850	4,419	4,950	20,293	3,964	3,210	2,834	2,129	12,137

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.
[1] Includes increase to major productive facilities. Listed categories are cootrol societies and reflect the consumption of all member plants of those societies.

Source: Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 67.—*Contracted and actual deliveries of lead by the Metals Distribution Control company, quarterly, fiscal years 1942–45* [1]

[In metric tons]

Year	Contracted deliveries					Total actual deliveries from warehouses
	Army	Navy	Indirect military and civilian	Aircraft	Total	
1942: [2]						
III	2,279	3,927	2,788	([3])	8,994	na
IV	3,542	11,066	1,367		15,975	na
Total	5,821	14,993	4,155		24,969	
1943:						
I	2,524	7,209	5,486		15,219	na
II	2,706	3,981	2,521		9,208	na
III	2,152	3,962	4,048		10,162	7,834
IV	1,848	4,327	1,806		7,981	8,150
Total	9,230	19,479	13,861		42,570	15,984
1944:						
I	2,304	5,012	2,736	51	10,103	18,460
II	2,600	8,162	7,059	2,455	20,276	14,529
III	2,260	4,762	4,189	937	12,148	13,250
IV	1,016	2,442	2,047	1,323	6,828	6,588
Total	8,180	20,378	16,031	4,766	49,355	52,827
1945:						
I	1,170	6,892	811	680	9,553	2,097
II	(91)	587	725	169	(1,572)	(4,911)
Total	(1,261)	7,479	1,536	849	(11,125)	(7,008)
Grand total	(24,492)	62,329	35,583	5,615	(128,019)	

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] The Metals Distribution Control company was designated as the only company to receive and distribute all refined metal whether imported or domestically produced.
[2] Data before October 1942 for contracted deliveries and for actual deliveries before October 1943 were destroyed.
[3] Contracted deliveries to "Aircraft" prior to 1944 were included under "Army" and "Navy".

Source: Metals Distribution Control company (KINZOKU HAIKYU TOSEI KAISHA), November 1945.

APPENDIX TABLE 68.—*Summary of Japanese zinc capacity and supply, fiscal years 1935–45*

[In metric tons]

Year	Capacity [1]				Supply												
	Japan proper		Korea electrolytic	Total (1 + 2 + 3)	Japan proper						Korea slab zinc production [4] electrolytic	Old scrap	Stocks at year end [9]	Total slab zinc production Japan proper and Korea (8 + 9 + 12)	Total imports to Japan proper (6 + 10)	Total zinc available [11] (11 + 12 + 13)
					Ores and concentrates (zinc content)			Slab zinc								
								Production		Imports [7]	Total (8+9+10)					
	Distilled [1]	Electrolytic [12]			Production [2]	Imports [3]	Total (5 + 6)	Distilled [5]	Electrolytic [12]							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1935	34,200	(10,000)	.....	(44,200)	(18,536)	(12,913)	(31,449)	26,295	(3,912)	32,763	(62,970)	.....	.....	na	(30,207)	(45,676)	(62,970)
1936	34,200	13,000	.....	47,200	(25,710)	(12,079)	(37,789)	29,049	(7,919)	42,030	(78,998)	.....	.....	na	(36,968)	(54,109)	(78,998)
1937	40,200	19,000	.....	59,200	(30,353)	(4,970)	(35,323)	38,137	(11,649)	37,086	(86,872)	.....	.....	na	(49,786)	(42,056)	(86,872)
1938	41,100	19,000	.....	60,100	(34,284)	(4,162)	(38,446)	41,312	(12,891)	28,012	(82,215)	.....	.....	na	(54,203)	(32,174)	(82,215)
1939	44,100	22,600	.....	66,700	(30,901)	(3,525)	(34,426)	39,926	(11,330)	58,220	(109,476)	.....	.....	na	(51,256)	(61,745)	(109,476)
1940	46,100	22,600	.....	68,700	56,679	(8,400)	(65,079)	48,341	11,762	23,473	83,576	.....	.....	na	60,103	(31,873)	83,576
1941	46,400	22,600	8,400	77,400	63,785	(6,815)	(70,600)	48,548	13,344	6,319	68,211	2,103	.....	26,285	63,995	(13,134)	70,314
1942	47,800	25,900	8,400	82,100	85,305	(6,082)	(91,387)	47,577	13,796	3,409	64,782	6,833	.....	(11,450)	68,206	(9,491)	71,615
1943	51,800	38,500	8,400	98,700	94,105	8,581	102,686	44,827	17,507	3,441	65,775	7,452	1,632	36,797	69,786	12,082	74,859
1944	51,800	43,000	8,400	103,200	74,939	7,187	82,126	43,284	17,673	671	61,628	5,475	820	33,614	66,432	7,858	67,923
1945	51,800	43,000	8,400	103,200	(10,829)	(2,527)	[8](13,356)	[6](8,966)	[6](2,947)	na	(11,913)	[8]1,527	93	[10]42,975	(13,440)	(2,527)	(13,533)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Some zinc capacity in lead and copper smelters not included, but quantities are very small.
[2] Prior to 1940 only production of Hosokura and Kamioka mines reported. Production from other mines, which was appreciable, not available.
[3] Prior to 1943 only imports of Mitsui Mining Co. are included, but these represent more than 75 percent of total imports.
[4] First quarter of fiscal year only.
[5] Prior to 1942 small quantities produced at lead and copper smelters not included.
[6] First and second quarters of fiscal year except that production of certain smelters for certain months in second quarter not included. Refer to Appendix Tables 71 and 72.
[7] After 1940 principally from French Indo-China. Exports of 269 tons in 1944 and 35 tons in 1945 have been disregarded.
[8] Estimated from Japan Mining Co. infomation for years 1941, 1942, and 1945.
[9] Stocks held by Metals Distribution Control Co. and by Japanese Army and Navy. Refer to Appendix Table 73.
[10] At end of fiscal year except for 1945 which was 15 August.
[11] Stocks not included.
[12] The Hibi refinery was purchased from the Showa Mining Co. by the Mitsui Mining Co. in 1943. Capacity and production data for prior years are incomplete. Refer to Appendix Tables 69 and 71.

Source: Japan proper data mainly from Bureau of Mines, Ministry of Commerce and Industry, November 1945. Korea data from Japan Mining Co., November 1945. Stock data from Metals Distribution Control Co. (KINZOKU HAIKYU TOSEI KAISHA) Japanese Army, and Japanese Navy, November 1945. For other specific sources, refer to the Appendix Tables 69, 70, 71, 72, and 73 giving further details of above data.

APPENDIX TABLE 69.—*Capacity of Japan's zinc smelters and refineries, fiscal years 1935–45*

(In metric tons)

Company	Plant	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Distilled—Japan proper	*Smelter*											
Japan Soda Co.	Aizu	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400
Mitsubishi Mining Co.	Hosokura	3,000	3,000	9,000	9,000	9,000	9,000	9,000	9,000	12,000	12,000	12,000
Mitsui Mining Co.	Hikoshima	5,800	5,800	5,800	6,700	9,700	11,700	12,000	13,400	14,400	14,400	14,400
Mitsui Mining Co.	Muke [2]	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Total distilled zinc [1]		34,200	34,200	40,200	41,100	44,100	46,100	46,400	47,800	51,800	51,800	51,800
Electrolytic—Japan proper	*Refinery*											
Mitsubishi Mining Co.	Naoshima	6,000	6,000	6,000	6,000	6,000	6,000	6,000	9,300	12,000	12,000	12,000
Mitsui Mining Co.[3]	Hibi [3]	na	[4] 3,000	[4] 3,000	[4] 3,000	[5] 6,600	[5] 6,600	[5] 6,600	[5] 6,600	12,000	12,000	12,000
Mitsui Mining Co.	Kamioka									4,500	9,000	9,000
Mitsui Mining Co.	Muke [3]	4,000	4,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Total electrolytic zinc		(10,000)	13,000	19,000	19,000	22,600	22,600	22,600	25,900	38,500	43,000	43,000
Total—Japan proper		(44,200)	47,200	59,200	60,100	66,700	68,700	69,000	73,700	90,300	94,800	94,800
Electrolytic—Korea												
Japan Mining Co.	Chinnampo							8,400	8,400	8,400	8,400	8,400
Grand total [1]		(44,200)	47,200	59,200	60,100	66,700	68,700	77,400	82,100	98,700	103,200	103,200

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Some capacity in lead and copper smelters not included, but quantities are very small.
[2] Breakdown of proportion of distilled and electrolytic zinc from Muke smelter estimated from Bureau of Mines data.
[3] The Hibi refinery was purchased from the Showa Mining Co. by the Mitsui Mining Co. in 1943. Capacity for 1935–42 inclusive was not reported by them.
[4] Reported as probable capacity by: Consular Report No. 46571, Tokyo, 1938.
[5] Reported as probable capacity by: *Metal Bulletin, World Register of Non-Ferrous Smelters and Refineries*, 1940.

Source: Bureau of Mines, Ministry of Commerce and Industry, for Aizu and Hibi smelters; Mitsui Mining Co. and Mitsubishi Mining Co. for other smelters in Japan proper; Japan Mining Co. for Korea, November 1945.

APPENDIX TABLE 70.—*Production of zinc ore by mine in Japan proper, and imports of zinc ore by source, fiscal years 1935-45*

(Zinc content in metric tons)

Company	Mine	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 [5]
Production												
Mitsubishi Mining Co.[1]	Hosokura	4,386	7,260	9,001	9,304	9,090	9,042	9,820	10,223	10,897	9,453	2,184
Mitsui Mining Co.[2]	Kamioka	14,150	18,450	21,352	24,980	21,811	28,491	32,079	34,529	43,097	38,422	8,645
Others		na	na	na	na	na	19,146	21,886	40,553	40,111	27,064	na
Total		(18,536)	(25,710)	(30,353)	(34,284)	(30,901)	56,679	63,785	85,305	94,105	74,939	(10,829)
Imports [3] *Source*												
Korea				(864)	(1,706)	(360)	(3,733)	(4,120)	3,096	2,811	2,745	(1,924)
Manchukuo [4]			(1,030)	(1,370)	(2,456)	(2,093)	(3,539)	(2,293)	2,137	5,516	4,442	603
China		(11,545)	(8,178)	(2,736)					(490)			
French Indo-China										232		
Burma									359	22		
Australia						(1,072)	(1,128)	(402)				
Canada		(658)	(380)									
Mexico		(710)	(2,491)									
Total		(12,913)	(12,079)	(4,970)	(4,162)	(3,525)	(8,400)	(6,815)	(6,082)	8,584	7,187	(2,527)
Production and imports		(31,449)	(37,789)	(35,323)	(38,446)	(34,426)	(65,079)	(70,600)	(91,387)	102,686	82,126	(13,356)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.

[1] Mitsubishi Mining company reports a total of 49,435 tons of zinc content in ore produced 1940–44 inclusive. Bureau of Mines reports 41,934 tons. Mitsubishi figures are given.
[2] Mitsui Mining Company reports a total of 304,533 tons of concentrate produced at Kamioka 1940–44 inclusive, which was 58 percent zinc, a zinc content of 176,618 tons. Bureau of Mines reports 160,243 tons zinc content which would indicate a zinc content of 53 per cent. Mitsui figures are given.
[3] Imports by Mitsui Mining Company only, when shown parenthetically as incomplete. This probably represents more than 75 percent of the total imports.
[4] The Manchurian Mining Company reported a total zinc ore production of 32,795 tons zinc content for years 1939–45 inclusive, compared to 20,683 tons reported above as imported.
[5] First quarter only.

Source: Bureau of Mines, Ministry of Commerce and Industry except as otherwise indicated, November 1945.

APPENDIX TABLE 71.—*Zinc production in Japan proper and Korea, by plants, fiscal years 1935-45*

(In metric tons)

Company	Plant	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 [3]
Distilled—Japan proper	*Smelter*											
Japan Soda Co.	Aizu	1,038	1,232	1,739	3,341	3,290	5,239	4,915	5,017	4,952	4,921	(956)
Mitsubishi Mining Co.	Hosokura	2,585	2,777	7,471	8,304	7,588	8,792	8,493	8,594	9,280	8,510	1,761
Mitsui Mining Co	Hikoshima	4,980	5,390	5,615	6,730	8,280	9,220	10,890	11,493	11,397	10,061	(2,075)
Mitsui Mining Co	Miike	17,692	19,650	23,312	22,937	20,768	25,090	24,250	19,744 [4]	18,391	18,824	4,174
Others		(1)	(1)	(1)	(1)	(1)	(1)	(1)	2,729	807	968	na
Total distilled zinc		26,295	29,049	38,137	41,312	39,926	48,341	48,548	47,577	44,827	43,284	(8,966)
Electrolytic—Japan proper	*Refinery*											
Mitsubishi Mining Co	Naoshima	2,472	5,053	5,465	5,810	5,117	5,052	5,574	6,776	7,115	3,167	100
Mitsui Mining Co	Hibi [2]	na	na	na	na	na	[4] 400	[4] 800	[4] 1,200	1,665	2,093	(232)
Mitsui Mining Co	Kamioka									2,599	6,406	(1,204)
Mitsui Mining Co	Miike	1,440	2,866	6,184	7,081	6,213	6,310	6,970	5,820	6,138	6,007	1,411
Total electrolytic zinc		(3,912)	(7,919)	(11,649)	(12,891)	(11,330)	11,762	13,344	13,796	17,507	17,673	(2,947)
Total—Japan proper		(30,207)	(36,968)	(49,786)	(54,203)	(51,256)	60,103	61,892	61,373	62,334	60,957	(11,913)
Electrolytic—Korea	*Refinery*											
Japan Mining Co.	Chunnampo							1,703	5,433	5,311	4,801	1,127
Others								400	1,400	2,141	674	400
Total—Korea								2,103	6,833	7,452	5,475	1,527
Grand total		(30,207)	(36,968)	(49,786)	(54,203)	(51,256)	60,103	63,995	68,206	69,786	66,432	(13,440)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] Information not available, but quantities believed to be negligible.
[2] The Hibi refinery was purchased from the Showa Mining Company by the Mitsui Mining company in 1943. Prior production data are not available, but production is estimated for years 1940, 1941, and 1942.
[3] 1945 production is complete for the months of April, May, and June except for the small productma in the "others" category. The production of one smelter for July and August is not included, and the production of four smelters for September is not included. The total, however, is more than 90 percent complete for the six-month period of the fiscal year
[4] Estimated from Japan Mining company. Information for years 1941, 1942, and 1945.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 72.—*Zinc production in Japan proper, by plants, monthly, fiscal years 1942-45*

[In metric tons]

1942

Company	Plant	April	May	June	July	August	September	October	November	December	Jannary	February	March	Total
Distilled	*Smelter*													
Japan Soda Co	Aizu	300	430	471	470	456	400	425	420	430	430	371	420	5,017
Mitsubishi Mining Co	Hosokura	784	702	829	697	668	518	567	710	740	769	762	848	8,594
Mitsui Mining Co	Hikoshima	973	975	966	968	913	930	951	926	1,001	991	884	1,015	11,493
Mitsui Mining Co	Miike	1,875	1,889	1,591	1,630	1,431	1,339	1,519	1,573	1,827	1,792	1,508	1,770	19,744
Others [1]		227	227	227	227	227	227	227	228	228	228	228	228	2,729
Total distilled zinc		4,159	4,223	4,084	3,992	3,689	3,414	3,689	3,857	4,226	4,210	3,753	4,281	47,577
Electrolytic	*Refinery*													
Mitsubishi Mining Co.	Naoshima	650	451	437	631	243	432	730	581	572	684	685	680	6,776
Mitsui Mining Co	Hibi [2]	100	100	100	100	100	100	100	100	100	100	100	100	1,200
Mitsui Mining Co.	Kamioka													
Mitsui Mining Co	Miike	482	503	496	482	385	454	482	482	506	512	385	553	5,820
Total electrolytic zinc		1,232	1,054	1,033	1,213	826	986	1,312	1,163	1,178	1,296	1,170	1,333	13,796
Grand total		5,391	5,277	5,117	5,205	4,515	4,400	5,001	5,020	5,404	5,506	4,923	5,614	61,373

1943

Distilled	*Smelter*													
Japan Soda Co	Aizu	460	374	430	511	502	502	420	395	380	333	305	340	4,952
Mitsubishi Mining Co.	Hosokura	887	887	752	822	770	700	778	775	700	765	700	744	9,280
Mitsui Mining Co	Hikoshima	943	929	928	951	963	1,065	957	965	924	949	866	957	11,397
Mitsui Mining Co	Miike	1,503	1,479	1,411	1,462	1,572	1,547	1,609	1,436	1,610	1,618	1,552	1,592	18,391
Others [3]		67	67	67	67	67	67	67	67	67	68	68	68	807
Total distilled zinc		3,860	3,736	3,588	3,813	3,874	3,881	3,831	3,638	3,681	3,733	3,491	3,701	44,827

See footnotes at end of table

APPENDIX TABLE 72.—*Zinc production in Japan proper, by plants, monthly, fiscal years 1942-45*—Continued

[In metric tons]

1943

Company	Plant	April	May	June	July	August	September	October	November	December	January	February	March	Total
Electrolytic	*Refinery*													
Mitsubishi Mining Co.	Naoshima	571	711	536	555	681	660	529	523	570	632	486	661	7,115
Mitsui Mining Co.	Hibi	67	242	246	145	104	83	96	74	102	159	99	238	1,655
Mitsui Mining Co.	Kamioka						103	351	385	401	452	450	457	2,599
Mitsui Mining Co.	Mike	509	495	499	477	510	520	510	505	521	520	515	557	6,138
Total electrolytic zinc		1,147	1,448	1,281	1,177	1,295	1,366	1,486	1,487	1,594	1,763	1,550	1,913	17,507
Grand total		5,007	5,184	4,869	4,990	5,169	5,247	5,317	5,125	5,275	5,496	5,041	5,614	62,334

1944

Distilled	*Smelter*													
Japan Soda Co.	Aizu	500	506	403	500	540	554	422	401	364	301	260	230	4,921
Mitsubishi Mining Co.	Hosokura	858	831	757	707	934	1,025	851	768	610	550	306	333	8,510
Mitsui Mining Co.	Hikoshima	1,020	1,044	984	807	687	704	695	675	833	855	748	1,009	10,061
Mitsui Mining Co.	Mike	1,599	1,618	1,562	1,438	1,602	1,735	1,669	1,580	1,618	1,612	1,377	1,414	18,824
Others[1]		80	80	80	80	81	81	81	81	81	81	81	81	968
Total distilled zinc		4,037	4,079	3,786	3,532	3,844	4,099	3,718	3,505	3,506	3,399	2,712	3,067	43,284
Electrolytic	*Refinery*													
Mitsubishi Mining Co.	Naoshima	700	650	453	494	311	183	168		208				3,167
Mitsui Mining Co.	Hibi	289	212	119	225	184	242	169	104	216	79	114	140	2,093
Mitsui Mining Co.	Kamioka	477	505	807	651	667	681	657	644	517	310	301	389	6,406
Mitsui Mining Co.	Mike	528	521	506	490	463	468	504	517	538	527	429	516	6,007
Total electrolytic zinc		1,994	1,888	1,685	1,860	1,625	1,574	1,498	1,265	1,479	916	844	1,045	17,673
Grand total		6,031	5,967	5,471	5,392	5,469	5,673	5,216	4,770	4,985	4,315	3,556	4,112	60,957

1945

Company	Plant	April	May	June	July	August	September	Total[3]
Distilled	*Smelter*							
Japan Soda Co.	Aizu	210	220	220	205	101	na	(956)
Mitsubishi Mining Co.	Hosokura	427	492	377	337	67	61	1,761
Mitsui Mining Co.	Hikoshima	531	555	423	326	240	na	(2,075)
Mitsui Mining Co.	Mike	1,325	1,401	778	523		147	4,174
Others		na	na	na	na	na	na	na
Total distilled zinc		(2,493)	(2,668)	(1,798)	(1,391)	(408)	(208)	(8,966)
Electrolytic	*Refinery*							
Mitsubishi Mining Co.	Naoshima		87	12	1			100
Mitsui Mining Co.	Hibi	74	74	84	na	na	na	(232)
Mitsui Mining Co.	Kamioka	344	291	229	263	77	na	(1,204)
Mitsui Mining Co.	Mike	508	340	257	212	8	86	1,411
Total electrolytic zinc		926	792	582	(476)	(85)	(86)	(2,947)
Grand total		(3,419)	(3,460)	(2,380)	(1,867)	(493)	(294)	(11,913)

na Indicates data not available.
( ) Figures in parentheses indicate totals for which one or more of the constituent figures are not available.
[1] Monthly break-downs of annual totals estimated.

[2] Production for Hibi refinery in 1942 is estimated.
[3] 6 months only, April to September inclusive. Total is more than 90 per cent complete for the 6-month period.

Source: Bureau of Mines, Ministry of Commerce and Industry, except for 1945 when data for all but Aizu and Hibi plants were supplied by Mitsui Mining company and Mitsubishi Mining company.

APPENDIX TABLE 73.—*Stocks of slab zinc, Japan proper, as of end of fiscal years 1941–45*

[In metric tons]

Period	Metals Distribution Control company	Army [1]	Navy [1]	Total
31 March 1942	[2] 12,235	5,000	9,050	26,282
31 March 1943	na	4,000	7,450	(11,450)
31 March 1944	27,147	3,000	6,650	36,797
31 March 1945	25,664	2,000	5,950	33,614
15 August 1945	24,626	11,000	7,349	42,975

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available

[1] Army and Navy stocks were estimated by them, and for 15 August 1945 include inventories.
[2] Metals Distribution Control company, as of 1 February 1942.

Source: Metals Distribution Control company (Kinzoku Haikyu Tosei Kaisha), Army and Navy, November 1945.

APPENDIX TABLE 74.—*Allocations and contracted deliveries of zinc in Japan, quarterly, fiscal years 1942–45*

[In metric tons]

Allocation	1942					1943					1944					1945		
	I	II	III	IV	Total	I	II	III	IV	Total	I	II	III	IV	Total	I	II	Total
Army	4,264	5,191	5,591	5,695	20,741	5,350	5,853	5,677	4,896	21,776	4,432	4,920	4,230	2,822	16,404	na	na	na
Navy	7,561	7,494	8,072	8,226	31,353	7,205	7,873	7,647	6,592	29,317	4,432	4,920	4,230	2,822	16,404	na	na	na
Indirect military and civilian	7,117	6,084	7,241	5,577	26,019	6,494	5,520	5,859	6,795	24,668	6,197	3,737	3,946	2,130	16,010	na	na	na
Aircraft	(1)	(1)	(1)	(1)		(1)	(1)	(1)	(1)	(1)	3,300	3,000	2,565	1,479	10,344	na	na	na
Shipbuilding	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	2,500	2,610	2,260	1,613	8,983	na	na	na
Total	18,942	18,769	20,904	19,498	78,113	19,049	19,246	19,183	18,283	75,761	20,861	19,187	17,231	10,866	68,145	na	na	na
Contracted Deliveries																		
Army	na	na	3,268	5,926	(9,194)	5,078	5,578	4,689	6,590	21,935	3,652	4,579	5,042	5,134	18,407	890	590	1,480
Navy	na	na	3,268	6,948	(10,216)	7,872	6,574	8,623	7,600	30,669	6,954	10,910	4,307	2,613	24,784	6,235	437	6,672
Indirect military and civilian	na	na	na	na	na	6,979	2,844	4,836	1,730	16,389	2,540	2,742	5,606	1,140	12,028	1,144	647	1,791
Aircraft	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	1,401	2,874	2,057	2,431	8,763	1,722	393	2,115
Total	na	na	(6,536)	(12,874)	(19,410)	19,929	14,996	18,148	15,920	68,993	14,547	21,105	17,012	11,318	63,982	9,991	2,067	12,058

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] Prior to 1944 allocations for aircraft were included in allotments to Army and Navy.
[2] Prior to 1944 shipbuilding allocations were not separated from other Navy allocations.

Source: Bureau of Mines, Ministry of Commerce and Industry, for allocations beginning II quarter 1942; Metals Distribution Control Co (KINZOKU HAIKYU TOSEI KAISHA) for allocations prior to II quarter, 1942 and for contracted deliveries. November 1945.

APPENDIX TABLE 75.—*Typical compositions of zinc concentrates as received by Japan, by mines*

[In per cent]

Company	Mine	Zn	Cu	Pb	Fe	Cd	S	Ag	Au	As
Fujita Mining Co	Hanaoka	36.45	4.50	5.48	10.58	.13	30.38	.0439	.00009	na
Mitsubishi Mining Co	Ikuno [1]	45.31	3.87	1.21	10.30	.21	31.32	.0326	.00006	na
Mitsui Mining Co	Kamioka [1]	58.70	.11	.41	5.58	.27	32.27	.0050	.00003	na
na	Ginseki	29.50			1.85	T	8.92		.00180	na
na	Kunitomi	50.13	1.43	.26	8.23	.23	34.14	.0131	.00012	na
na	Mozumi	56.4	.22	1.05	6.6	.35	29.8	.0070	na	.10
na	Shikama	58.9	.20	1.00	4.9	.34	30.2	.0104	na	.10
na	Tochibora	58.9	.17	.55	5.0	.35	30.2	.0082	na	.10
na (Korea)	Seisen	51.30	.55	2.89	4.98	.46	30.02	.0192	.00030	na
na (Manchukuo)	Tenposan	38.34	4.40	4.82	6.70	.22	25.28	.0518	.00031	na
na (Burma)	na	56.55	.13	3.40	3.30	.30	30.46	.0233	.00010	na
na (Australia)	na	51.58	.20	2.15	7.75	.15	30.86	.0093	T	na

na Indicates data not available.
[1] Chief sources for Hikoshima, Kamioka and Muke smelters during the war.

Source: Mitsui Mining Company, Hikoshima and Kamioka smelters, November 1945.

APPENDIX TABLE 76.—*Typical zinc content of concentrates received by Miike zinc smelter, annually, 1935–40, monthly, 1941–45*

(Per cent)

	1935	1936	1937	1938	1939	1940
Average	53.50	54.40	55.50	54.13	51.90	55.20

	1941	1942	1943	1944	1945
January	54.60	54.60	52.00	53.50	52.14
February	55.60	56.70	56.10	55.90	48.10
March	55.50	56.20	54.80	54.40	51.99
April	55.80	55.10	52.10	57.50	55.49
May	55.20	55.00	54.00	54.40	53.15
June	53.30	54.36	54.30	55.20	55.16
July	54.60	51.30	53.30	55.90	
August	54.70	54.50	51.20	55.10	
September	54.80	52.80	52.50	55.30	
October	54.60	51.90	54.00	53.16	
November	53.30	55.30	52.50	55.03	
December	54.80	51.70	51.50	53.81	
Average	54.73	54.12	53.19	54.93	52.67

Source: Mitsui Mining Co, Ltd, Miike zinc smelter, November 1945.

APPENDIX TABLE 77.—*Typical compositions of Japan's zinc, fiscal years 1935–45*

[In percent]

	Distilled zinc								Electrolytic zinc									
	Mitsui Mining Co.								Mitsubishi Mining Co.		Mitsui Mining Co.							
	Hikoshima plant				Miike plant				Hosokura plant	Naoshima plant	Kamioka plant					Miike plant			
	Zn [1]	Pb	Cd	Fe	Zn [1]	Pb	Cd	Fe	Zn	Zn	Zn [1]	Pb	Cd	Fe	Ag	Zn [1]	Pb	Cd	Fe
1935	98.639	1.087	.25	.024	98.685	1.143	.152	.020	na	na	.....	na	na	na	na	.....	na	na	na
1936	98.635	1.069	.27	.026	98.794	1.085	.099	.022	na	na	.....	na	na	na	na	.....	na	na	na
1937	98.743	1.014	.22	.023	98.705	1.127	.150	.018	na	na	.....	na	na	na	na	.....	na	na	na
1938	98.818	.968	.19	.024	98.648	1.176	.168	.008	na	na	.....	na	na	na	na	.....	na	na	na
1939	98.666	1.028	.28	.026	98.653	1.125	.213	.009	na	na	.....	na	na	na	na	.....	na	na	na
1940	98.669	1.061	.24	.030	98.673	1.099	.219	.009	na	na	.....	na	na	na	na	99.973	.024	T	.003
1941 January	98.728	.980	.26	.032	98.652	1.123	.216	.009	99.96	99.97	.....	na	na	na	na	99.979	.019	T	.002
1942 January	98.623	1.045	.31	.022	98.580	1.134	.280	.006	99.97	99.96	.....	na	na	na	na	99.971	.026	T	.003
1943 January	98.782	.920	.27	.028	98.654	1.082	.253	.011	99.96	99.95	99.989	.004	T	.005	.002	99.965	.034	T	.001
1943 July	98.689	1.057	.23	.024	98.642	1.090	.259	.009	99.91	99.96	99.989	.004	T	.005	.002	99.969	.026	T	.005
1944 January	98.628	1.090	.26	.022	98.647	1.131	.212	.010	99.93	99.96	99.989	.004	T	.005	.002	99.966	.031	T	.003
1944 July	98.840	.840	.28	.040	98.681	1.132	.181	.006	99.94	99.96	99.989	.004	T	.005	.002	99.977	.020	T	.003
1945 January	98.682	1.000	.29	.028	98.704	1.047	.243	.006	99.90	99.96	99.989	.004	T	.005	.002	99.964	.030	.0001	.005
1945 July	98.648	1.040	.28	.032	98.738	1.045	.210	.007	99.96	99.96	99.989	.004	T	.005	.002	99.976	.022	T	.002

na Indicates data not available.

[1] Zinc by difference.

Source: Mitsubishi Mining company and Mitsui Mining company, November 1945.

APPENDIX TABLE 78.—*Summary of total Japanese tin producing capacity and supply, fiscal years 1935-45*

[In metric tons of metal content]

Year	Smelter [1]	Refinery [2]	Supply (production, imports, scrap, and stockpiles)									
			Ore and concentrates			Crude tin production [4]	Refined tin			Scrap production [6]	Stockpiles [7]	
			Production	Imports	Total (3 and 4)		production	Imports	Total (7 and 8)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
1935	na	(2,400)	[3] (920)	na	(920)	na	[2] (2,095)	[5] 4,251	(6,346)	na		na
1936	na	(2,400)	[3] (1,516)	na	(1,516)	na	[2] (1,770)	[5] 4,718	(6,488)	na		na
1937	na	(2,400)	[3] (1,605)	na	(1,605)	na	[2] (3,600)	[5] 4,331	(5,931)	na		na
1938	na	(3,000)	[3] (1,517)	na	(1,517)	na	[2] (1,523)	[5] 8,744	(10,267)	na		na
1939	na	(3,000)	[3] (1,423)	na	(1,423)	na	[2] (1,398)	[5] 7,964	(9,362)	na		na
1940	(2,400)	(3,000)	[3] (1,463)	na	(1,463)	2,039	[2] (1,453)	[5] 10,868	(12,321)	na		na
1941	(3,600)	(3,000)	[3] (1,277)	1,636	(2,913)	4,079	[2] (1,911)	[5] 5,480	(7,391)	na		na
1942	(3,600)	(3,000)	1,917	996	2,913	3,626	3,816	11,055	14,871	na	Feb. 1942	7,322
1943	(3,600)	(3,000)	1,120	586	1,706	1,787	1,815	26,766	28,581	134	3/31/43	9,316
1944	(3,600)	(1,000)	380	----------	380	536	772	16,965	17,737	95	3/31/44	13,053
1945 [8]	(3,600)	(1,000)	[3] (49)	----------	(49)	66	(61)	3,007	(3,068)	na	8/15/45	10,155

na Indicates data not available. ( ) Indicates totals for which one or more of the constituent figures are not available.

[1] This represents only the Ikuno smelter of the Mitsubishi Mining company, which is the only significant tin smelter in Japan.
[2] This represents only the Mitsubishi Copper refinery at Osaka, which is the only large tin refinery in Japan.
[3] Includes only the Akenobe mine estimated at two-thirds total production.
[4] Includes small amounts of low grade refined tin.
[5] Calendar year. No imports of refined metal January-March 1942.
[6] Old scrap estimated by the Japanese Bureau of Mines to be allocated as scrap on the estimate that 30 per cent of total scrap is refined again.
[7] Sum of the refined metal stocks held by the Metals Distribution Control company (KINZOKU HAIKYO TOSEI KAISHA), Army, and Navy. The Army and Navy figures are estimated by those organizations. The stock for February 1942 includes Army and Navy figures for 31 March 1942.
[8] 1 April-15 August except for capacity which is annual.

Source: Bureau of Mines, Ministry of Commerce and Industry; Mitsubishi Mining company; Metals Distribution Control company (KINZOKU HAIKYU TOSEI KAISHA) November 1945.

APPENDIX TABLE 79.—*Crude tin capacity in Japan proper, by smelter, fiscal years 1940–45*

[In metric tons]

Company	Plant	1940	1941	1942	1944	1945
Mitsubishi Mining Co.	Ikuno	2,400	3,600	3,600	3,600	3,600
Others		na	na	na	na	na
Total		(2,400)	(3,600)	(3,600)	(3,600)	(3,600)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

Source: Mitsubishi Mining company; Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 80.—*Refined tin capacity in Japan proper, by refinery, fiscal years 1935–45*

[In metric tons]

Company	Plant	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Mitsubishi Mining Co.	Mitsubishi Copper refinery, Osaka	2,400	2,400	2,400	3,000	3,000	3,000	3,000	3,000	3,000	1,000	1,000
Mitsubishi Mining Co.	Ikuno	na	na	na	na	na	na	na	na	na	na	na
Others		na	na	na	na	na	na	na	na	na	na	na
Total		(2,400)	(2,400)	(2,400)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(1,000)	(1,000)

na Indicates data not available. ( ) Indicates totals for which one or more of the constituent figures are not available.

Source: Mitsubishi Mining company; Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 81.—*Production of tin ore in Japan proper, by mine, fiscal years 1935–45*

[In metric tons of metal content]

Company	Name	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 (April-August)
Mitsubishi Mining Co.	Akenobe	920	1,516	1,605	1,517	1,423	1,463	1,277	1,233	713	296	49
Tayo Mining Co.	Mitate	na	na	na	na	na	na	na	292	229	66	na
Others		na	na	na	na	na	na	na	392	178	18	na
Total		(920)	(1,516)	(1,605)	(1,517)	(1,423)	(1,463)	(1,277)	1,917	1,120	380	(49)

na Indicates data not available. ( ) Indicates totals for which one or more of the constituent figures are not available.

Source: Bureau of Mines, Ministry of Commerce and Industry supplemented by figures from the Mitsubishi Mining Co., November 1945.

APPENDIX TABLE 82.—*Production of tin ore in the largest tin mine in Japan proper, monthly, fiscal years 1942–45* [1]

[In metric tons of metal content]

Month	1942	1943	1944	1945
April	104	84	37	13
May	110	84	32	13
June	110	71	36	11
July	123	65	32	7
August	125	70	33	4
September	112	70	34	- -
October	100	50	20	
November	100	41	15	
December	94	40	15	
January	80	48	15	
February	82	51	13	
March	93	42	14	
Total	1,233	713	296	49

[1] Mitsubishi Mining company's Akenobe mine.

Source: Mitsubishi Mining company, November 1945.

APPENDIX TABLE 83.—*Production of crude tin in Japan proper, by smelter, fiscal years 1940–45*

[In metric tons]

Company	Smelter	1940	1941	1942	1943	1944	1945 (Apr.-Aug.)
Mitsubishi Mining Co.	Ikuno	1,699	3,181	[1] 2,461	[1] 1,480	[1] 510	[1] 66
Other		340	898	1,165	307	26	
Total		2,039	4,079	3,626	1,787	536	66

[1] Mitsubishi Mining company report. Includes small amounts of low-grade refined tin.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 84.—*Production of crude tin in the largest tin smelter in Japan proper, monthly, fiscal years 1942–45* [1]

[In metric tons]

Month	1942	1943	1944	1945
April	137	157	46	44
May	393	160	31	2
June	310	144	78	10
July	282	116	72	10
August	374	193	78	- -
September	118	181	56	- -
October	109	50	20	- -
November	151	40	54	- -
December	116	57	50	- -
January	164	182	12	- -
February	145	143	2	- -
March	162	57	11	- -
Total	2,461	1,480	510	66

[1] Mitsubishi Mining company's Ikuno smelter. Figures include some refined tin, but most of the tin (averaging 95 per cent Sn) is shipped to the Mitsubishi Copper refinery in Osaka for refining.

Source: Mitsubishi Mining company, November 1945.

APPENDIX TABLE 85.—*Production of refined tin in Japan proper, by refinery, fiscal years 1935-45*

[In metric tons]

Company	Refinery	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945 (Apr.-Aug.)
Mitsubishi Mining Co.	Mitsubishi Copper refinery, Osaka	2,095	1,770	1,600	1,523	1,398	1,453	1,911	2,065	1,159	606	61
Others		na	na	na	na	na	na	na	1,751	656	166	na
Total		(2,095)	(1,770)	(1,600)	(1,523)	(1,398)	(1,453)	(1,911)	3,816	1,815	772	(61)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 86. *Production of refined tin in the largest tin refinery in Japan proper, monthly, fiscal years 1942–45* [1]

[In metric tons]

Month	1942	1943	1944	1945
April	192	122	.....	30
May	190	130	64	24
June	164	107	81	.....
July	161	134	82	.....
August	182	147	83	7
September	245	53	76	.....
October	205	106	57	.....
November	153	152	57	.....
December	155	123	44	.....
January	153	61	24	.....
February	131	17	23	.....
March	134	7	15	.....
Total	2,065	1,159	606	61

[1] Mitsubishi Mining coompany's Mitsubishi Copper refinery in Osaka.

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 87.—*Imports of tin concentrates to Japan proper, by country of origin, monthly, fiscal years 1941–43*

[In metric tons of metal content]

Year and month	Country of origin			Total
	Thailand	French Indo-China	South China	
1941				
April	266	60	.....	326
May	156	.....	.....	156
June	.....	.....	.....	.....
July	.....	.....	.....	.....
August	15	.....	.....	15
September	.....	.....	.....	.....
October	161	.....	4	165
November	112	56	.....	168
December	305	57	31	393
January	234	40	.....	274
February	114	.....	.....	114
March	25	.....	.....	25
Total	1,388	213	35	1,636
1942				
April	.....	.....	.....	.....
May	.....	.....	.....	.....
June	255	191	.....	446
July	163	.....	.....	163
August	.....	.....	.....	.....
September	38	.....	.....	38
October	.....	.....	.....	.....
November	.....	.....	.....	.....
December	15	240	.....	255
January	10	.....	.....	10
February	10	.....	.....	10
March	74	.....	.....	74
Total	565	431	.....	906
1943				
April	.....	129	.....	129
May	.....	.....	.....	.....
June	305	.....	.....	305
July	.....	89	.....	89
August	.....	.....	.....	.....
September	.....	.....	.....	.....
October	.....	.....	.....	.....
November	.....	.....	.....	.....
December	63	.....	.....	63
January	.....	.....	.....	.....
February	.....	.....	.....	.....
March	.....	.....	.....	.....
Total	368	218	.....	586

Source: Bureau of Mines, Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 88.—*Imports of refined tin to Japan proper, 1933–45*

[In metric tons]

Year [1]	Country of origin			Total
	Straits Settlements Dutch East Indies	China	Others	
1935	2,659	1,587	5	4,251
1936	2,680	1,873	165	4,718
1937	2,124	401	1,806	4,331
1938	4,613	17	4,114	8,744
1939	7,960	4	.....	7,964
1940	10,433	.....	435	10,868
1941	5,473	.....	7	5,480

Month	1942 [2]	1943 [2]	1944 [2]	1945 [2]
April	.....	1,362	1,348	1,481
May	226	5,971	660	1,826
June	1,163	3,965	4,104	.....
July	.....	2,256	2,408	.....
August	3	1,839	144	.....
September	31	369	3,805	.....
October	241	3,000	2,901	.....
November	657	2	509	.....
December	1,486	851	490	.....
January	1,493	1,856	300	.....
February	4,083	3,419	74	.....
March	1,672	1,876	222	.....
Total	11,055	26,766	16,965	3,007

[1] Calendar year. No imports January–March 1942.
[2] All imports from Straits Settlements and Dutch East Indies.

Source: Bureau of Mines, Ministry of Commerce and Industry; Metals Distribution Control company (Kinzokn Haikyu Tozei Kaisha), November 1945.

APPENDIX TABLE 89.—*Stock piles of tin in Japan proper, 1941–45*

[In metric tons]

Date	Metal Distribution Control company	Army [1]	Navy [1]	Total
2 February 1942	1,232	[2] 5,000	[2] 1,090	7,322
31 March 1943	2,126	6,000	1,190	9,316
31 March 1944	6,363	5,000	1,690	13,053
15 August 1945	4,697	4,000	1,458	10,155

[1] Estimated by the Army and Navy.
[2] For 31 March 1942. It is believed that the stock was at least this large on 7 December 1941.

Source: Metals Distribution Control company (KINZOKU HAIKYU TOSEI KAISHA), Army, and Navy, November 1945.

APPENDIX TABLE 90.—*Total Japanese allocations of tin to Army, Navy, and other general categories, quarterly, fiscal years 1942–44*

[In metric tons]

Year	Army	Navy	Indirect military and civilian	Aircraft	Shipping	Special (Shusui)	Total
1942:							
I	na	na	na	(1)			na
II	384	1,008	1,506				2,898
III	145	246	969				1,360
IV	714	1,222	1,024				2,960
Total	(1,243)	(2,476)	(3,499)				(7,218)
1943:							
I	1,442	2,091	1,552				5,085
II	600	869	1,333				2,802
III	1,446	2,091	1,205				4,742
IV	1,444	2,090	2,482				6,016
Total	4,932	7,141	6,572				18,645
1944:							
I	873	981	1,228	1,036	571		4,689
II	948	1,072	831	1,225	610		4,686
III	na	na	na	na	na	na	na
IV	380	429	798	621	276	825	3,329
Total	(2,201)	(2,482)	(2,857)	(2,882)	(1,457)	(825)	(12,704)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available
[1] Aircraft and shipping allocations were included in Army and Navy categories prior to 1944.

Source: Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 91.—*Japanese Navy tin distribution according to specific use, fiscal years 1940–45*

[In metric tons]

Category	1940	1941	1942	1943	1944	1945 (to end of war)
General Navy use						
Guns and ammunition	187	276	373	606	605	48
Torpedoes and mines	150	201	298	486	482	38
Electrical equipment	128	193	251	401	405	35
Optical and navigational Instruments	36	41	56	86	86	8
Shipbuilding	118	195	249	411	403	31
Engines	615	916	1,238	2,007	1,999	156
Other equipment	16	21	25	45	42	4
Total	1,250	1,843	2,490	4,042	4,022	320
Aircraft use						
Aircraft frames	6	9	14	20	2	1
Aircraft engines	16	23	21	32	4	2
Guns and bombs	8	11	18	24	3	1
Electrical instruments	24	35	58	108	8	3
Optical instruments and gauges	16	24	35	56	7	2
Base construction machinery	73	108	168	326	27	9
Construction, repairing materials	17	26	46	80	7	2
Total	160	236	360	646	58	20
Grand total	1,410	2,079	2,850	4,688	4,080	340

Source: Japanese Navy Technical and Aircraft departments, November 1945.

APPENDIX TABLE 92.—*Japanese allocation of tin to indirect military and civilian uses, quarterly, fiscal years 1942-44*

[In metric tons]

Category	1942					1943					1944				
	I	II	III	IV	Total	I	II	III	IV	Total	I	II	III	IV	Total
Specific indirect military and civilian demands:[1]															
Iron and steel	na	26	22	23	(71)	48	89	45	11	193	15	44	na	9	(68)
Coal mining	na	18	17	35	(70)	30	25	28	30	113	32	..	na	7	(39)
Light metals	na	2	2	19	(23)	24	35	18	41	118	15	14	na	9	(38)
Metal mining	na	12	14	15	(41)	28	15	22	24	89	40	21	na	2	(63)
Electric power	na	29	27	29	(85)	34	30	30	33	127	22	5	na	7	(34)
Liquid fuel	na	58	54	43	(155)	36	116	73	42	267	11	6	na	19	(36)
Machine tool	na	87	82	89	(258)	195	141	219	187	742	42	2	na	4	(48)
Automobile	na	21	20	22	(63)	19	18	28	19	84	43	53	na	13	(109)
Metals	na	..	..	na	..	..	..	..	..	..	30	..	na	1	(31)
Chemicals	na	7	7	5	(19)	9	5	9	14	37	16	26	na	14	(56)
Others	na	..	..	..	na	..	..	..	..	..	2	1	na	1	(4)
Total	na	260	245	280	(785)	423	474	472	401	1,770	268	172	na	86	(526)
Official demands	na	67	61	55	(183)	126	106	128	868	1,228	50	61	na	15	(126)
General civilian demands	na	125	126	141	(392)	102	157	76	79	414	233	257	na	101	(591)
Exports to colonies	na	102	99	101	(302)	208	247	172	64	691	150	120	na	184	(454)
Exports	na	221	225	240	(686)	178	178	169	161	686	127	105	na	125	(357)
Others	na	731	213	207	(1,151)	515	171	188	909	1,783	400	116	na	288	(804)
Grand total	na	1,506	969	1,024	(3,499)	1,552	1,333	1,205	2,482	6,572	1,228	831	na	799	(2,858

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] Includes increase to major industrial productive facilities.

Source: Ministry of Commerce and Industry, November 1945.

APPENDIX TABLE 93.—*Contracted and actual deliveries of tin by the Metals Distribution Control company, quarterly, fiscal years 1942-45* [1]

[In metric tons]

Year	Contracted deliveries					Total actual deliveries from warehouses
	Army	Navy	Indirect military and civilian	Aircraft	Total	
1942:						
I	na	na	na	(2)	na	1,327
II	na	na	na	..	na	2,513
III	na	na	na	..	na	2,447
IV	1,247	1,038	na	..	(2,285)	7,234
Total	1,247	1,038	na	..	(2,285)	13,551
1943:						
I	698	1,389	908	..	2,995	3,393
II	1,387	1,567	1,014	..	3,968	9,016
III	1,297	1,781	2,263	..	5,341	4,339
IV	1,208	2,018	1,136	..	4,362	7,732
Total	4,590	6,755	5,321	..	16,666	24,680
1944:						
I	2,033	2,527	583	18	5,161	6,743
II	1,494	3,619	2,736	660	8,509	8,280
III	510	1,117	815	446	2,888	4,546
IV	51	240	531	912	1,734	1,839
Total	4,088	7,503	4,665	2,036	18,292	21,408
1945:						
I	156	379	412	287	1,234	1,524
July–15 August	57	398	61	103	619	na
Total	213	777	473	390	1,853	1,524
Grand total	10,138	16,073	(10,459)	2,426	(39,096)	(61,163)

na Indicates data not available.
( ) Indicates totals for which one or more of the constituent figures are not available.

[1] The Metals Distribution Control company was the company officially authorized to handle the physical distribution of all refined metals whether imported or domestically produced.

[2] Allocations and deliveries to a separate aircraft authority were not begun until 1944. Before that year they were included under Army and Navy.

Source: Metals Distribution Control company (KINZOKU HAIKYU TOSEI KAISHA), November 1945.

UNITED STATES STRATEGIC BOMBING SURVEY

LIST OF REPORTS

The following is a bibliography of reports resulting from the Survey's studies of the European and Pacific wars. Those reports marked with an asterisk (*) may be purchased from the Superintendent of Documents at the Government Printing Office, Washington, D. C.

European War

OFFICE OF THE CHAIRMAN

*1 The United States Strategic Bombing Survey: Summary Report (European War)
*2 The United States Strategic Bombing Survey: Over-all Report (European War)
*3 The Effects of Strategic Bombing on the German War Economy

AIRCRAFT DIVISION

(By Division and Branch)

*4 Aircraft Division Industry Report
5 Inspection Visits to Various Targets (Special Report)

Airframes Branch

6 Junkers Aircraft and Aero Engine Works, Dessau, Germany
7 Erla Maschinenwerke G m b H, Heiterblick, Germany
8 A T G Maschinenbau, G m b H, Leipzig (Mockau), Germany
9 Gothaer Waggonfabrik, A G, Gotha, Germany
10 Focke Wulf Aircraft Plant, Bremen, Germany
11 Messerschmitt A G, Augsburg, Germany — Over-all Report; Part A; Part B; Appendices I, II, III
12 Dornier Works, Friedrichshafen & Munich, Germany
13 Gerhard Fieseler Werke G m b H, Kassel, Germany
14 Wiener Neustaedter Flugzeugwerke, Wiener Neustadt, Austria

Aero Engines Branch

15 Bussing NAG Flugmotorenwerke G m b H, Brunswick, Germany
16 Mittel-Deutsche Motorenwerke G m b H, Taucha, Germany
17 Bavarian Motor Works Inc, Eisenach & Durrerhof, Germany
18 Bayerische Motorenwerke A G (BMW) Munich, Germany
19 Henschel Flugmotorenwerke, Kassel, Germany

Light Metal Branch

20 Light Metals Industry of Germany — Part I, Aluminum; Part II, Magnesium
21 Vereinigte Deutsche Metallwerke, Hildesheim, Germany
22 Metallgussgesellschaft G m b H, Leipzig, Germany
23 Aluminiumwerk G m b H, Plant No. 2, Bitterfeld, Germany
24 Gebrueder Giulini G m b H, Ludwigshafen, Germany
25 Luftschiffbau, Zeppellin G m b H, Friedrichshafen on Bodensee, Germany
26 Wieland Werke A G, Ulm, Germany
27 Rudolph Rautenbach Leichmetallgiessereien, Solingen, Germany
28 Lippewerke Vereinigte Aluminiumwerke A G, Lunen, Germany
29 Vereinigte Deutsche Metallwerke, Hedderheim, Germany
30 Duerener Metallwerke A G, Duren Wittenau-Berlin & Waren, Germany

AREA STUDIES DIVISION

*31 Area Studies Division Report
32 A Detailed Study of the Effects of Area Bombing on Hamburg
33 A Detailed Study of the Effects of Area Bombing on Wuppertal
34 A Detailed Study of the Effects of Area Bombing on Dusseldorf
35 A Detailed Study of the Effects of Area Bombing on Solingen
36 A Detailed Study of the Effects of Area Bombing on Remscheid
37 A Detailed Study of the Effects of Area Bombing on Darmstadt
38 A Detailed Study of the Effects of Area Bombing on Lubeck
39 A Brief Study of the Effects of Area Bombing on Berlin, Augsburg, Bochum, Leipzig, Hagen, Dortmund, Oberhausen, Schweinfurt, and Bremen

CIVILIAN DEFENSE DIVISION

*40 Civilian Defense Division—Final Report
41 Cologne Field Report
42 Bonn Field Report
43 Hanover Field Report
44 Hamburg Field Report—Vol. I, Text; Vol. II, Exhibits
45 Bad Oldesloe Field Report
46 Augsburg Field Report
47 Reception Areas in Bavaria, Germany

EQUIPMENT DIVISION

Electrical Branch

*48 German Electrical Equipment Industry Report
49 Brown Boveri et Cie, Mannheim Kafertal, Germany

Optical and Precision Instrument Branch

*50 Optical and Precision Instrument Industry Report

Abrasives Branch

*51 The German Abrasive Industry
52 Mayer and Schmidt, Offenbach on Main, Germany

Anti-Friction Branch

*53 The German Anti-Friction Bearings Industry

Machine Tools Branch

*54 Machine Tools & Machinery as Capital Equipment
*55 Machine Tool Industry in Germany
56 Herman Kolb Co., Cologne, Germany
57 Collet and Engelhard, Offenbach, Germany
58 Naxos Union, Frankfort on Main, Germany

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59 The Defeat of the German Air Force
60 V-Weapons (Crossbow) Campaign
61 Air Force Rate of Operation
62 Weather Factors in Combat Bombardment Operations in the European Theatre
63 Bombing Accuracy, USAAF Heavy and Medium Bombers in the ETO
64 Description of RAF Bombing
64a The Impact of the Allied Air Effort on German Logistics

MORALE DIVISION

*64b The Effects of Strategic Bombing on German Morale (Vol. I and Vol. II)

Medical Branch

*65 The Effect of Bombing on Health and Medical Care in Germany

MUNITIONS DIVISION

Heavy Industry Branch

*66 The Coking Industry Report on Germany
67 Coking Plant Report No. 1, Sections A, B, C, & D
68 Gutehoffnungshuette, Oberhausen, Germany
69 Friedrich-Alfred Huette, Rheinhausen, Germany
70 Neunkirchen Eisenwerke A G, Neunkirchen, Germany
71 Reichswerke Hermann Goering A G, Hallendorf, Germany
72 August Thyssen Huette A G, Hamborn, Germany
73 Friedrich Krupp A G, Borbeck Plant, Essen, Germany
74 Dortmund Hoerder Huettenverein, A G, Dortmund, Germany
75 Hoesch A G, Dortmund, Germany
76 Bochumer Verein fuer Gusstahlfabrikation A G, Bochum, Germany

Motor Vehicles and Tanks Branch

*77 German Motor Vehicles Industry Report
*78 Tank Industry Report
79 Daimler Benz A G, Unterturkheim, Germany
80 Renault Motor Vehicles Plant, Billancourt, Paris
81 Adam Opel, Russelheim, Germany
82 Daimler Benz-Gaggenau Works, Gaggenau, Germany
83 Maschinenfabrik Augsburg-Nurnberg, Nurnberg, Germany
84 Auto Union A G, Chemnitz and Zwickau, Germany
85 Henschel & Sohn, Kassel, Germany
86 Maybach Motor Works, Friedrichshafen, Germany
87 Voigtlander, Maschinenfabrik A G, Planen, Germany
88 Volkswagenwerke, Fallersleben, Germany
89 Bussing NAG, Brunswick, Germany
90 Muehlenbau Industrie A G (Miag) Brunswick, Germany
91 Friedrich Krupp Grusonwerke, Magdeburg, Germany

Submarine Branch

92 German Submarine Industry Report
93 Maschinenfabrik Augsburg-Nurnberg A G, Augsburg, Germany
94 Blohm and Voss Shipyards, Hamburg, Germany
95 Deutschewerke A. G, Kiel, Germany
96 Deutsche Schiff und Maschinenbau, Bremen, Germany
97 Friedrich Krupp Germaniawerft, Kiel, Germany
98 Howaldtswerke A. G, Hamburg, Germany
99 Submarine Assembly Shelter, Farge, Germany
100 Bremer Vulkan, Vegesack, Germany

Ordnance Branch

*101 Ordnance Industry Report
102 Friedrich Krupp Grusonwerke A. G, Magdeburg, Germany
103 Bochumer Verein fuer Gusstahlfabrikation A G, Bochum, Germany
104 Henschel & Sohn, Kassel, Germany
105 Rheinmetall-Borsig, Dusseldorf, Germany
106 Hermann Goering Werke, Braunschweig, Hallendorf, Germany
107 Hannoverische Maschinenbau, Hanover, Germany
108 Gusstahlfabrik Friedrich Krupp, Essen, Germany

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*109 Oil Division, Final Report
*110 Oil Division, Final Report, Appendix
*111 Powder, Explosives, Special Rockets and Jet Propellants, War Gases and Smoke Acid (Ministerial Report #1)
112 Underground and Dispersal Plants in Greater Germany
113 The German Oil Industry, Ministerial Report Team 78
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115 Ammoniakwerke Merseburg G m b H, Leuna, Germany—2 Appendices
116 Braunkohle Benzin A G, Zeitz and Bohlen, Germany Wintershall A G, Leutzkendorf, Germany
117 Ludwigshafen-Oppau Works of I G Farbenindustrie A G, Ludwigshafen, Germany
118 Ruhroel Hydrogenation Plant, Bottrop-Boy, Germany, Vol. I, Vol. II
119 Rhenania Ossag Mineraloelwerke A G, Harburg Refinery, Hamburg, Germany
120 Rhenania Ossag Mineraloelwerke A G, Grasbrook Refinery, Hamburg, Germany
121 Rhenania Ossag Mineraloelwerke A G, Wilhelmsburg Refinery, Hamburg, Germany
122 Gewerkschaft Victor, Castrop-Rauxel, Germany, Vol. I & Vol. II
123 Europaeische Tanklager und Transport A G, Hamburg, Germany
124 Ebano Asphalt Werke A G, Harburg Refinery, Hamburg, Germany
125 Meerbeck Rheinpreussen Synthetic Oil Plant—Vol. I & Vol II

Rubber Branch

126 Deutsche Dunlop Gummi Co., Hanau on Main, Germany
127 Continental Gummiwerke, Hanover, Germany
128 Huels Synthetic Rubber Plant
129 Ministerial Report on German Rubber Industry

Propellants Branch

130 Elektrochemischewerke, Munich, Germany
131 Schoenebeck Explosive Plant, Lignose Sprengstoff Werke G m b H, Bad Salzemen, Germany
132 Plants of Dynamit A G, Vormal, Alfred Nobel & Co., Troisdorf, Clausthal, Drummel and Duneberg, Germany
133 Deutsche Sprengchemie G m b H, Kraiburg, Germany

OVER-ALL ECONOMIC EFFECTS DIVISION

134 Over-all Economic Effects Division Report
Gross National Product
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Hermann Goering Works
Food and Agriculture
} Special papers which together comprise the above report
134a Industrial Sales Output and Productivity

PHYSICAL DAMAGE DIVISION

134b Physical Damage Division Report (ETO)
135 Villacoublay Airdrome, Paris, France
136 Railroad Repair Yards, Malines, Belgium
137 Railroad Repair Yards, Louvain, Belgium
138 Railroad Repair Yards, Hasselt, Belgium
139 Railroad Repair Yards, Namur, Belgium
140 Submarine Pens, Brest, France
141 Powder Plant, Angouleme, France
142 Powder Plant, Bergerac, France
143 Coking Plants, Montigny & Liege, Belgium
144 Fort St. Blaise Verdun Group, Metz, France
145 Gnome et Rhone, Limoges, France
146 Michelin Tire Factory, Clermont-Ferrand, France
147 Gnome et Rhone Aero Engine Factory, Le Mans, France
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162 Area Survey at Pirmasens, Germany
163 Hanomag, Hanover, Germany
164 M A N Werke Augsburg, Augsburg, Germany
165 Friedrich Krupp A G, Essen, Germany
166 Erla Maschinenwerke G m b H, Heiterblick, Germany
167 A T G Maschinenbau G m b H, Mockau, Germany
168 Erla Maschinenwerke G m b H, Mockau, Germany
169 Bayerische Motorenwerke, Durrerhof, Germany
170 Mittel-Deutsche Motorenwerke G m b H, Taucha, Germany
171 Submarine Pens Deutsche-Werft, Hamburg, Germany
172 Multi-Storied Structures, Hamburg, Germany
173 Continental Gummiwerke, Hanover, Germany
174 Kassel Marshalling Yards, Kassel, Germany
175 Ammoniawerke, Merseburg-Leuna, Germany
176 Brown Boveri et Cie, Mannheim, Kafertal, Germany
177 Adam Opel A G, Russelsheim, Germany
178 Daimler-Benz A G, Unterturkheim, Germany
179 Valentin Submarine Assembly, Farge, Germany
180 Volkswaggonwerke, Fallersleben, Germany
181 Railway Viaduct at Bielefeld, Germany
182 Ship Yards Howaldstwerke, Hamburg, Germany
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